Snowmass**2013**

Community Planning Meeting aka CPM

High Energy Frontier

Michael Peskin (SLAC)
Chip Brock (MSU)

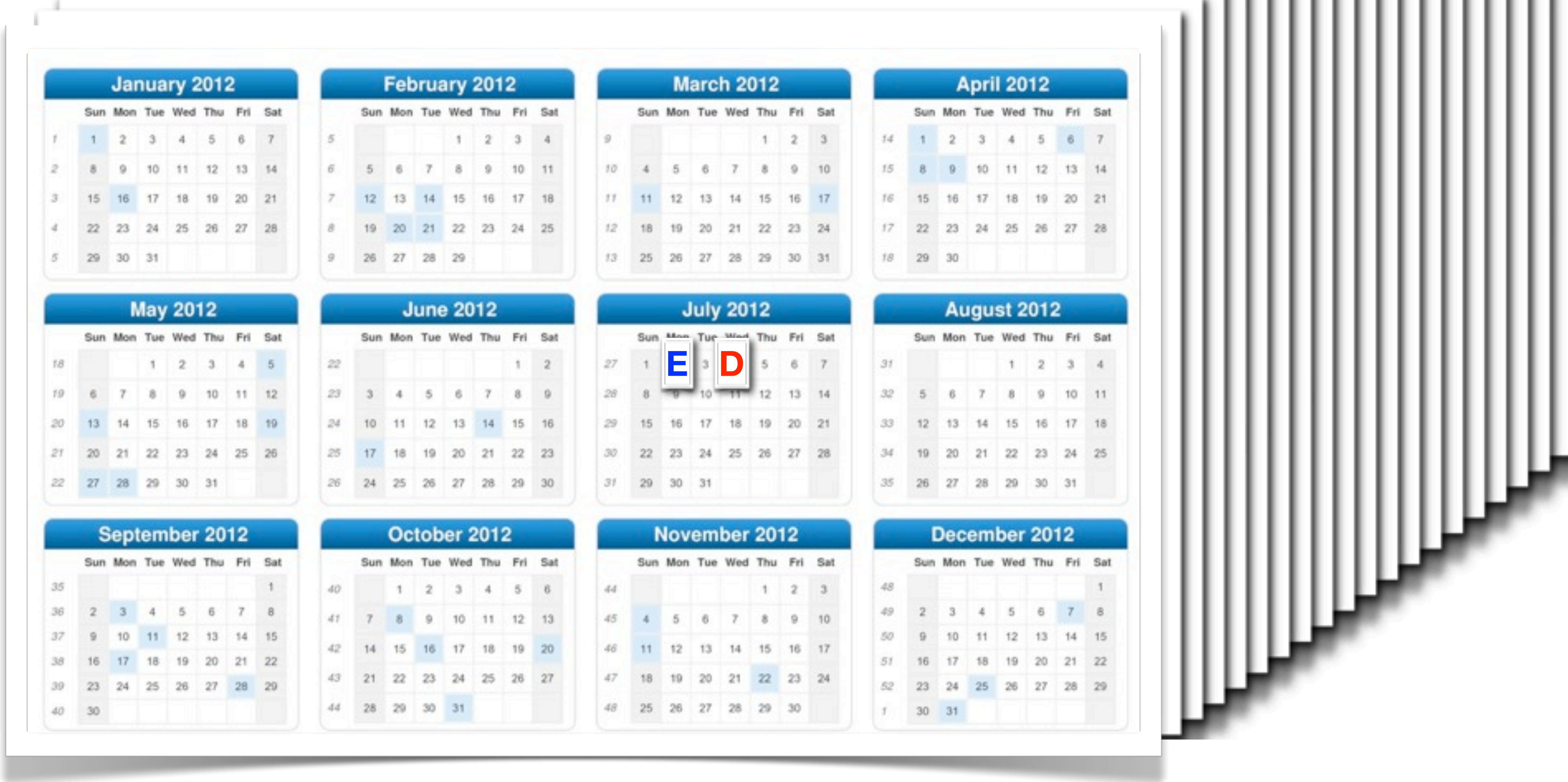
TOC:

Snowmass is about: following the physics

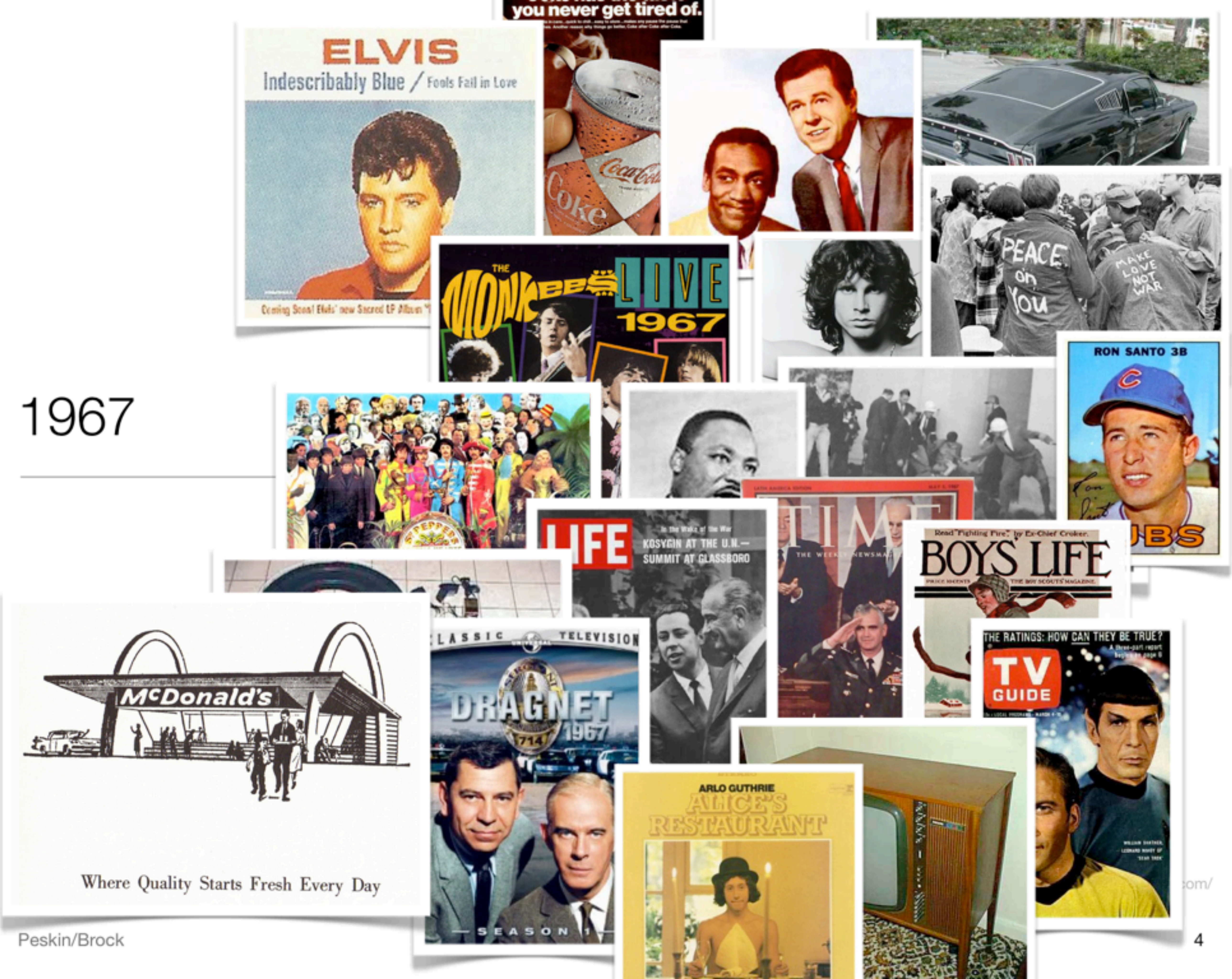
and the route has just gotten a little clearer.

From 1967 to July

It’s been a long 45 years

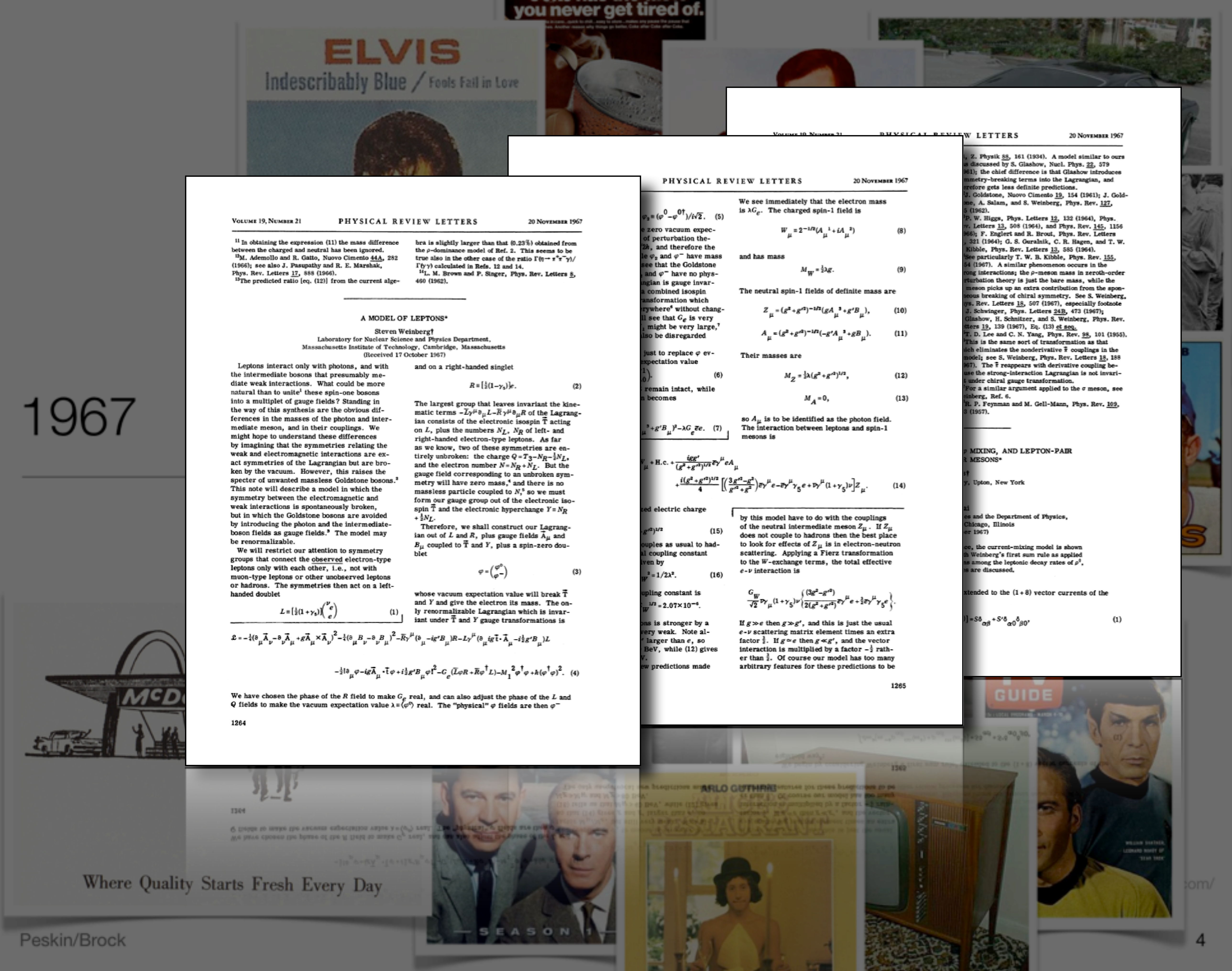


1967



you never get tired of.
ELVIS
Indescribably Blue / Fools Fall in Love
Coke
Coca-Cola
THE MONKEES LIVE 1967
PEACE on You
MAKE LOVE NOT WAR
RON SANTO 3B
CUBS
LIFE
In the Wake of the War
KOSYGIN AT THE U.N.—
SUMMIT AT GLASSBORO
TIME
Read "Fighting Fire," by Ex-Chief Croker.
BOYS' LIFE
THE RATINGS: HOW CAN THEY BE TRUE?
TV GUIDE
CLASSIC TELEVISION
DRAGNET 1967
714
SEASON 1
ARLO GUTHRIE
ALICE'S RESTAURANT
McDonald's
Where Quality Starts Fresh Every Day

1967



[11] In obtaining the expression (11) the mass difference between the charged and neutral has been ignored.
[12] M. Ademollo and R. Gatto, Nuovo Cimento 44A, 282 (1966); see also J. Pasupathy and R. E. Marshak, Phys. Rev. Letters 17, 888 (1966).
[13] The predicted ratio [eq. (12)] from the current algebra is slightly larger than that (0.23%) obtained from the ρ-dominance model of Ref. 2. This seems to be true also in the other case of the ratio $\Gamma(\eta\to\pi^+\pi^-\gamma)/\Gamma(\gamma\gamma)$ calculated in Refs. 12 and 14.
[14] L. M. Brown and P. Singer, Phys. Rev. Letters 8, 460 (1962).

A MODEL OF LEPTONS*

Steven Weinberg†
Laboratory for Nuclear Science and Physics Department,
Massachusetts Institute of Technology, Cambridge, Massachusetts
(Received 17 October 1967)

Leptons interact only with photons, and with the intermediate bosons that presumably mediate weak interactions. What could be more natural than to unite[1] these spin-one bosons into a multiplet of gauge fields? Standing in the way of this synthesis are the obvious differences in the masses of the photon and intermediate meson, and in their couplings. We might hope to understand these differences by imagining that the symmetries relating the weak and electromagnetic interactions are exact symmetries of the Lagrangian but are broken by the vacuum. However, this raises the specter of unwanted massless Goldstone bosons.[2] This note will describe a model in which the symmetry between the electromagnetic and weak interactions is spontaneously broken, but in which the Goldstone bosons are avoided by introducing the photon and the intermediate-boson fields as gauge fields.[3] The model may be renormalizable.

We will restrict our attention to symmetry groups that connect the observed electron-type leptons only with each other, i.e., not with muon-type leptons or other unobserved leptons or hadrons. The symmetries then act on a left-handed doublet

$$L=[\tfrac{1}{2}(1+\gamma_5)]\binom{\nu_e}{e} \quad (1)$$

and on a right-handed singlet

$$R=[\tfrac{1}{2}(1-\gamma_5)]e. \quad (2)$$

The largest group that leaves invariant the kinematic terms $-\bar{L}\gamma^\mu\partial_\mu L-\bar{R}\gamma^\mu\partial_\mu R$ of the Lagrangian consists of the electronic isospin $\vec{T}$ acting on L, plus the numbers N_L, N_R of left- and right-handed electron-type leptons. As far as we know, two of these symmetries are entirely unbroken: the charge $Q=T_3-N_R-\frac{1}{2}N_L$, and the electron number $N=N_R+N_L$. But the gauge field corresponding to an unbroken symmetry will have zero mass,[4] and there is no massless particle coupled to N,[5] so we must form our gauge group out of the electronic isospin $\vec{T}$ and the electronic hyperchange $Y=N_R+\frac{1}{2}N_L$.

Therefore, we shall construct our Lagrangian out of L and R, plus gauge fields $\vec{A}_\mu$ and B_μ coupled to $\vec{T}$ and Y, plus a spin-zero doublet

$$\varphi=\binom{\varphi^0}{\varphi^-} \quad (3)$$

whose vacuum expectation value will break $\vec{T}$ and Y and give the electron its mass. The only renormalizable Lagrangian which is invariant under $\vec{T}$ and Y gauge transformations is

$$\mathfrak{L}=-\tfrac{1}{4}(\partial_\mu\vec{A}_\nu-\partial_\nu\vec{A}_\mu+g\vec{A}_\mu\times\vec{A}_\nu)^2-\tfrac{1}{4}(\partial_\mu B_\nu-\partial_\nu B_\mu)^2-\bar{R}\gamma^\mu(\partial_\mu-ig'B_\mu)R-L\gamma^\mu(\partial_\mu ig\vec{t}\cdot\vec{A}_\mu-i\tfrac{1}{2}g'B_\mu)L$$
$$-\tfrac{1}{2}|\partial_\mu\varphi-ig\vec{A}_\mu\cdot\vec{t}\varphi+i\tfrac{1}{2}g'B_\mu\varphi|^2-G_e(\bar{L}\varphi R+\bar{R}\varphi^\dagger L)-M_1^2\varphi^\dagger\varphi+h(\varphi^\dagger\varphi)^2. \quad (4)$$

We have chosen the phase of the R field to make G_e real, and can also adjust the phase of the L and Q fields to make the vacuum expectation value $\lambda=\langle\varphi^0\rangle$ real. The "physical" φ fields are then φ^-

Peskin/Brock

“Ninety percent of this game is half mental.

The most precise theory in the history of physics

Quantity	Value	Standard Model	Pull	Dev.
M_Z [GeV]	91.1876 ± 0.0021	91.1874 ± 0.0021	0.1	0.0
Γ_Z [GeV]	2.4952 ± 0.0023	2.4961 ± 0.0010	−0.4	−0.2
$\Gamma(\text{had})$ [GeV]	1.7444 ± 0.0020	1.7426 ± 0.0010	—	—
$\Gamma(\text{inv})$ [MeV]	499.0 ± 1.5	501.69 ± 0.06	—	—
$\Gamma(\ell^+\ell^-)$ [MeV]	83.984 ± 0.086	84.005 ± 0.015	—	—
σ_{had}[nb]	41.541 ± 0.037	41.477 ± 0.009	1.7	1.7
R_e	20.804 ± 0.050	20.744 ± 0.011	1.2	1.3
R_μ	20.785 ± 0.033	20.744 ± 0.011	1.2	1.3
R_τ	20.764 ± 0.045	20.789 ± 0.011	−0.6	−0.5
R_b	0.21629 ± 0.00066	0.21576 ± 0.00004	0.8	0.8
R_c	0.1721 ± 0.0030	0.17227 ± 0.00004	−0.1	−0.1
$A_{FB}^{(0,e)}$	0.0145 ± 0.0025	0.0[illegible]3 ± 0.00021	−0.7	−0.7
$A_{FB}^{(0,\mu)}$	0.0169 ± 0.0013	[illegible]	0.4	0.6
$A_{FB}^{(0,\tau)}$	0.0188 ± 0.0017	[illegible]	1.5	1.6
$A_{FB}^{(0,b)}$	0.0992 ± 0.0016	0.10[illegible].0007	−2.6	−2.3
$A_{FB}^{(0,c)}$	0.0707 ± 0.0035	[illegible]005	−0.9	[illegible]
$A_{FB}^{(0,s)}$	0.0976 ± 0.01[illegible]	[illegible]07	[illegible]	[illegible]
$\bar{s}_\ell^2(A_{FB}^{(0,q)})$	0.2324 ± 0.00[illegible]	[illegible]	[illegible]	[illegible]
	0.23200 ± 0.[illegible]	[illegible]	[illegible]	[illegible]
	0.2287 ± 0.0[illegible]	[illegible]	[illegible]	[illegible]
A_e	0.15138 ± 0.0[illegible]	[illegible]	[illegible]	[illegible]
	0.1544 ± 0.006[illegible]	[illegible]	[illegible]	[illegible]
	0.1498 ± 0.004[illegible]	[illegible]	0.5	[illegible]
A_μ	0.142 ± 0.015	[illegible]	−0.4	−0.3
A_τ	0.136 ± 0.015	[illegible]	−0.8	−0.7
	0.1439 ± 0.0043	[illegible]	−0.8	−0.7
A_b	0.923 ± 0.020	0.9348 ± 0.0001	−0.6	−0.6
A_c	0.670 ± 0.027	0.6680 ± 0.0004	0.1	0.1
A_s	0.895 ± 0.091	0.9357 ± 0.0001	−0.4	− 0.4

Quantity	Value	Standard Model	Pull	Dev.
m_t [GeV]	173.4 ± 1.0	173.5 ± 1.0	−0.1	−0.3
M_W [GeV]	80.420 ± 0.031	80.381 ± 0.014	1.2	1.6
	80.376 ± 0.033		−0.2	0.2
$g_V^{\nu e}$	-0.040 ± 0.015	-0.0398 ± 0.0003	0.0	0.0
$g_A^{\nu e}$	-0.507 ± 0.014	-0.5064 ± 0.0001	0.0	0.0
$Q_W(e)$	-0.0403 ± 0.0053	-0.0474 ± 0.0005	1.3	1.3
$Q_W(\text{Cs})$	-73.20 ± 0.35	-73.23 ± 0.02	0.1	0.1
$Q_W(\text{Tl})$	-116.4 ± 3.6	-116.88 ± 0.03	0.1	0.1
τ_τ [fs]	291.13 ± 0.43	290.75 ± 2.51	0.1	0.1
$\frac{1}{2}(g_\mu - 2 - \frac{\alpha}{\pi})$	$(4511.07 \pm 0.77) \times 10^{-9}$	$(4508.70 \pm 0.09) \times 10^{-9}$	3.0	3.0

J. Beringer *et al.*(PDG), PR **D86**, 010001 (2012) (http://pdg.lbl.gov)

Peskin/Brock, HE Frontier, October 2012


Standard
Model

Standard

Model

standard |ˈstandərd|
noun
1. a level of quality or attainment

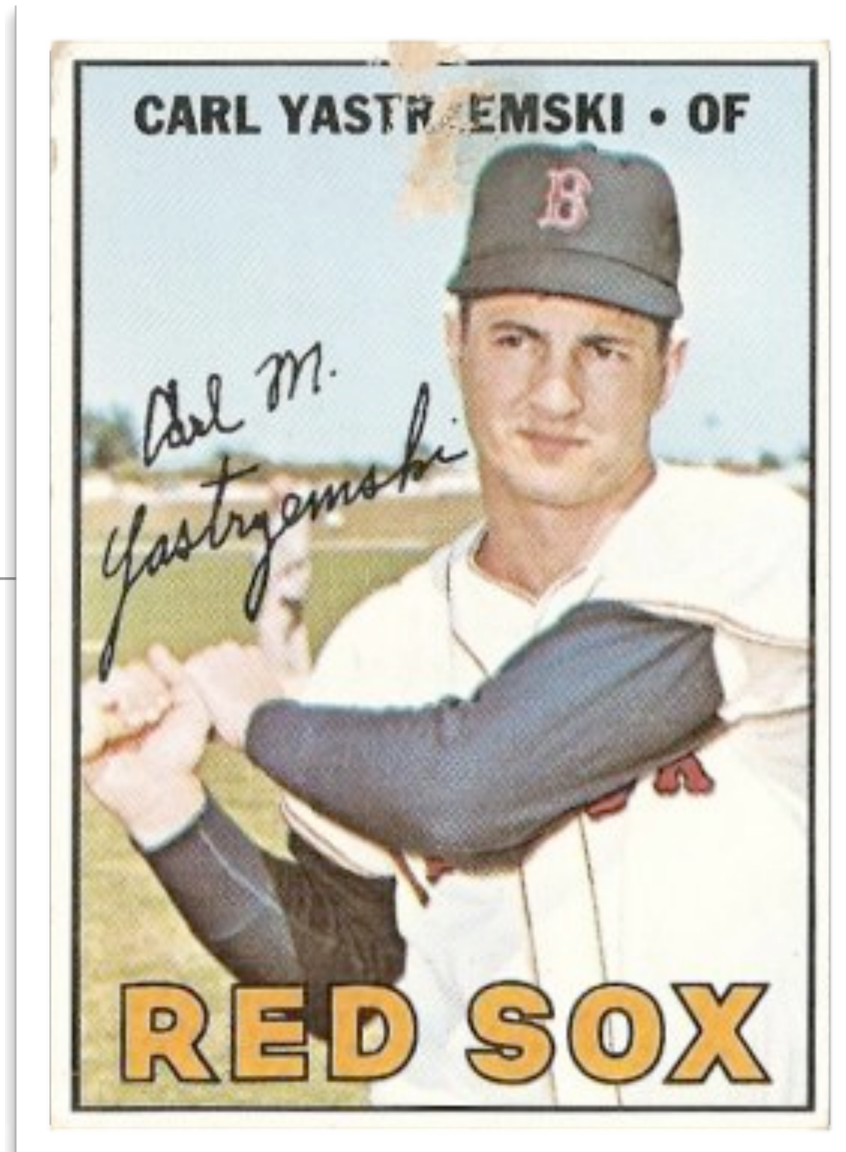
model |ˈmädl|
noun
2. a simplified description, esp. a mathematical one, of a system or process, to assist calculations and predictions

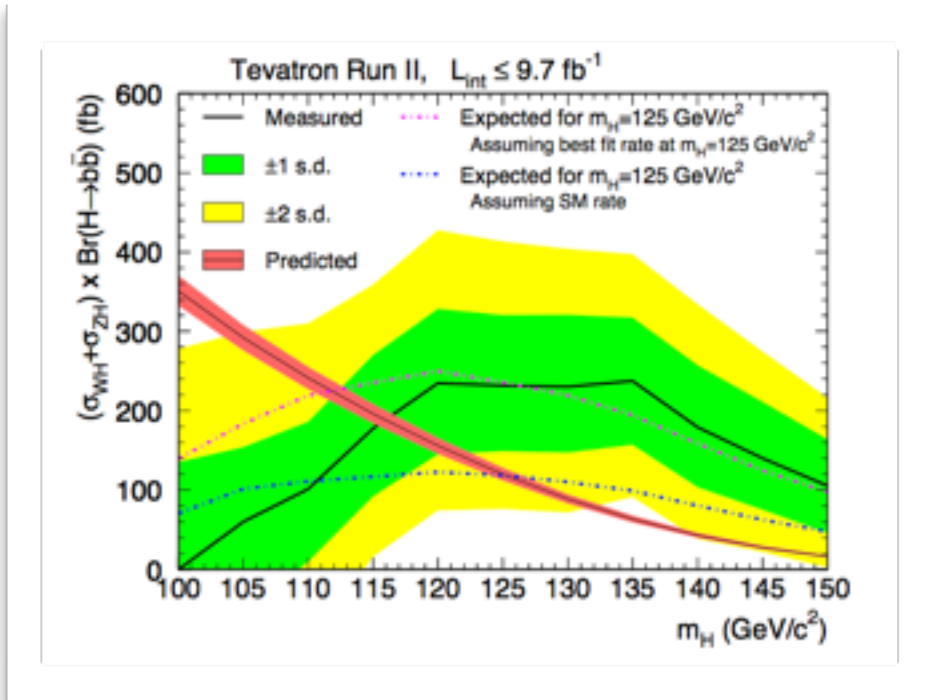
1967 - 2012

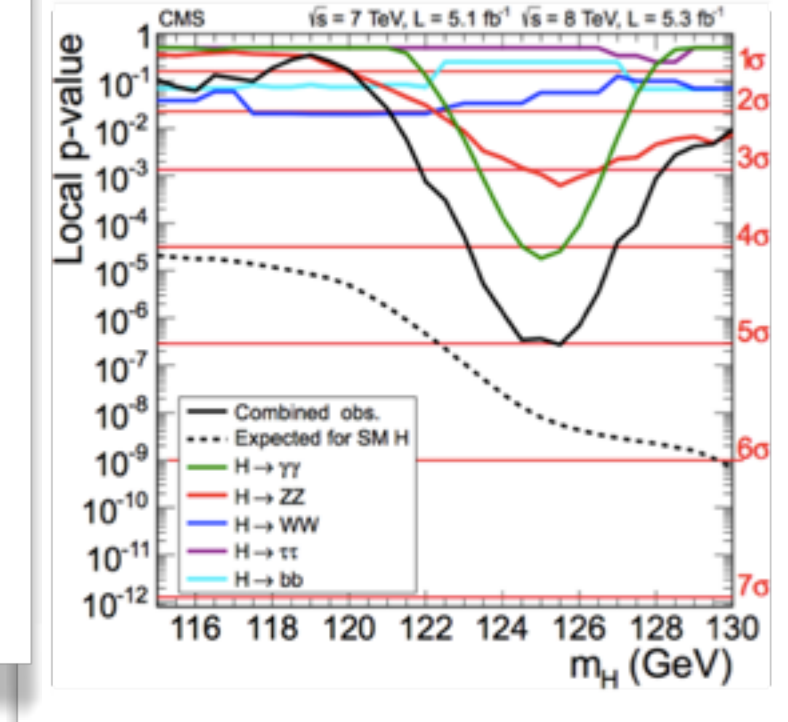
history was made

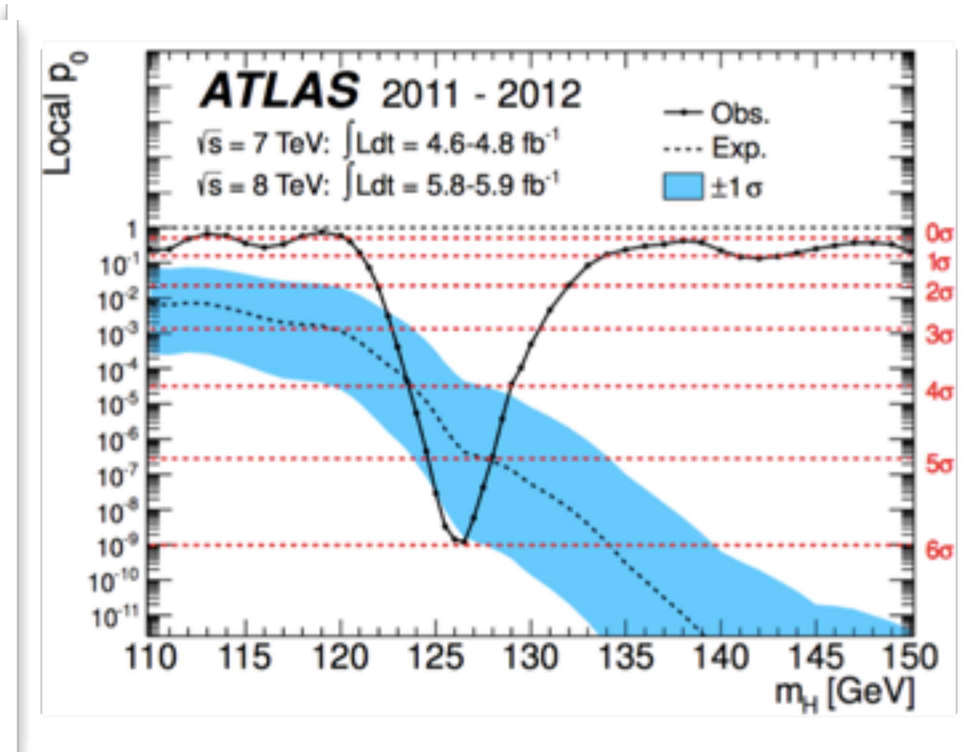
1967 - 2012

history was made









1967 - 2012

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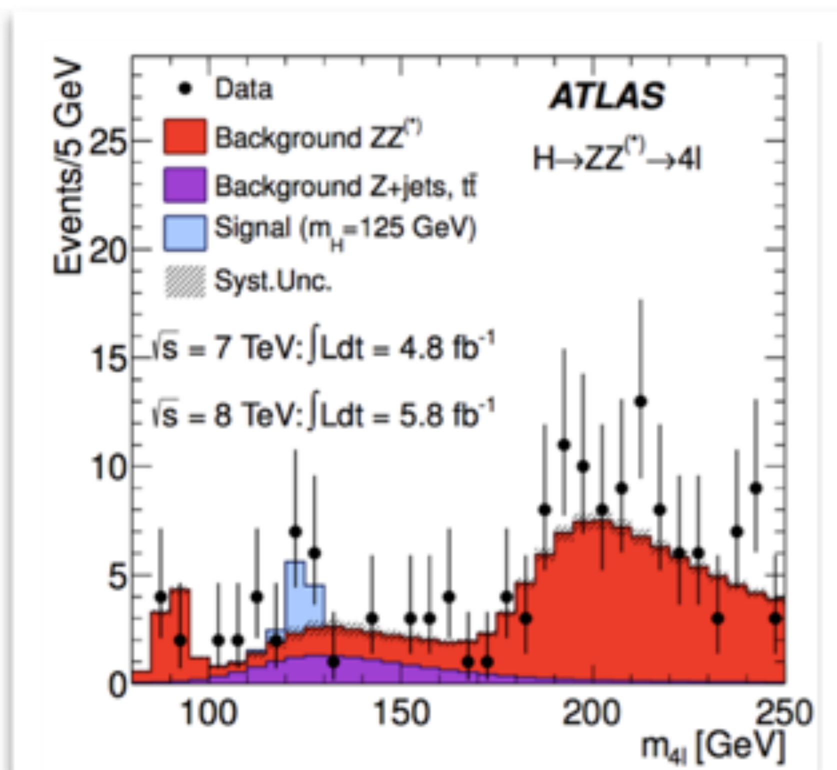
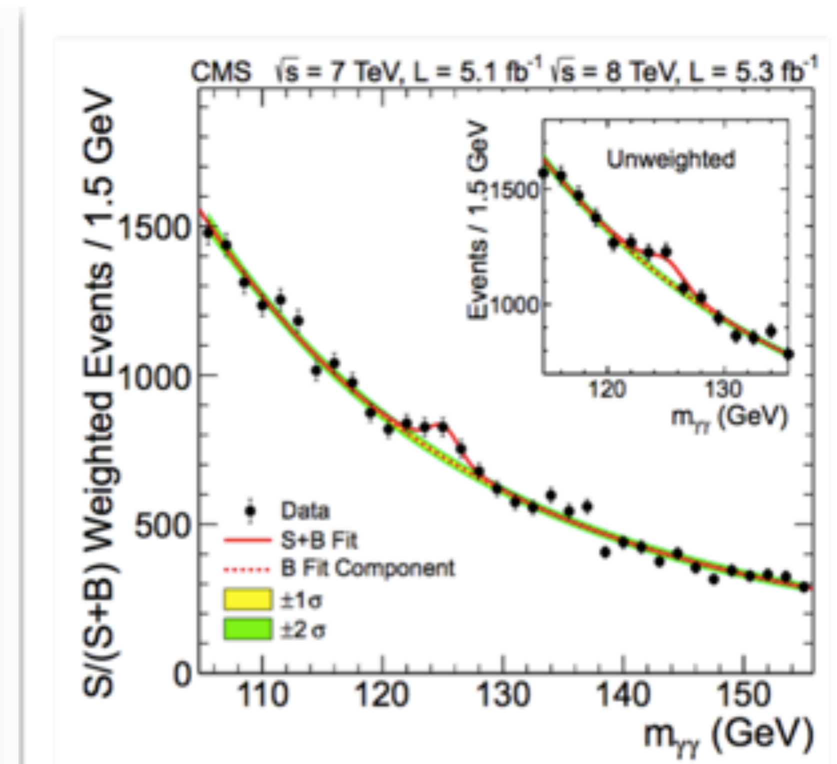
history was made



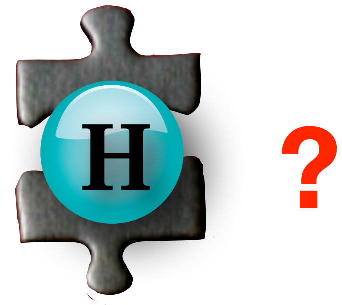
arXiv:1207.7214v1 [hep-ex]

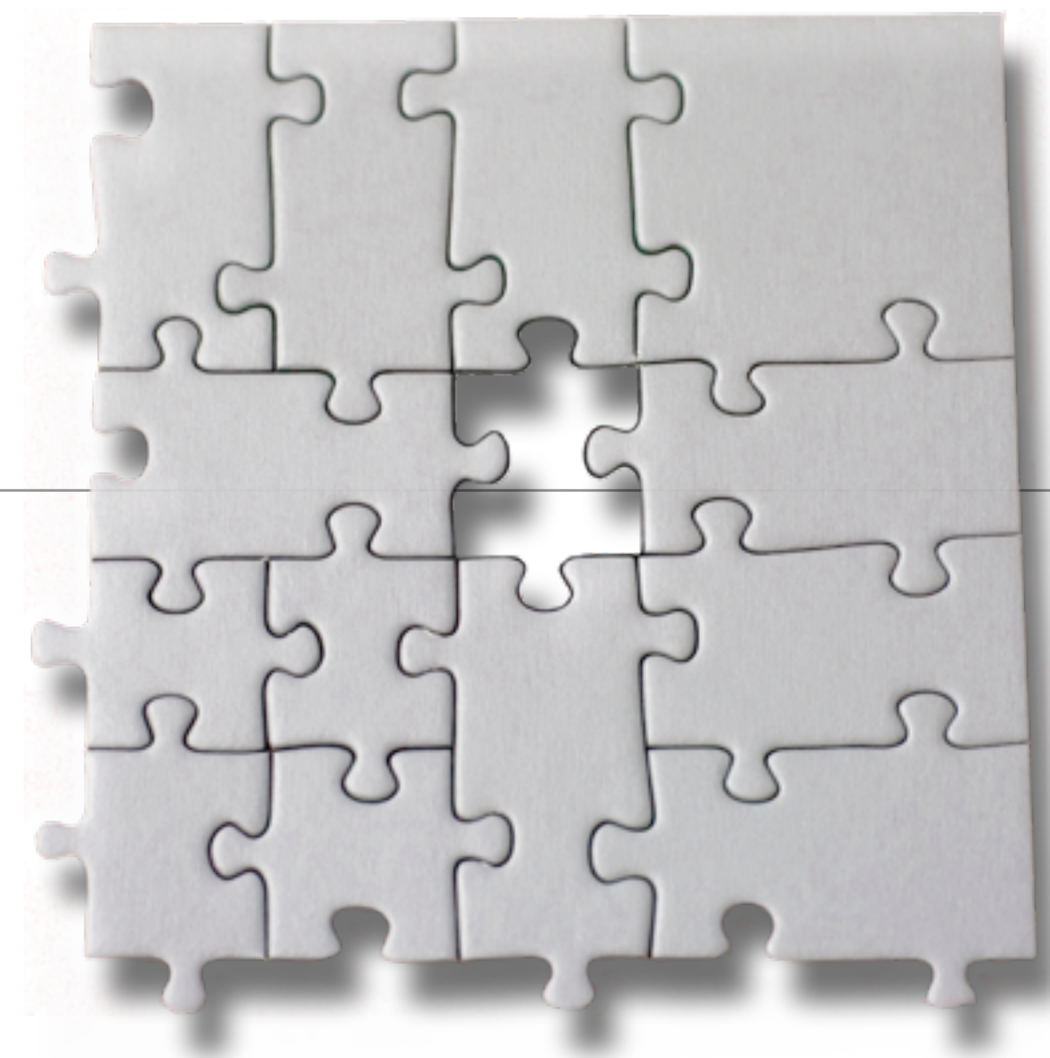


arXiv:1207.7235v1 [hep-ex]

Peskin/Brock

“I always thought that record would stand until it was broken.





Standard Model

tempting to think that the puzzle is solved

But we know better

The High Energy Frontier has 4 jobs:

Job 1. *follow the obvious experimental imperative*

Job 2. *unravel some confusions*

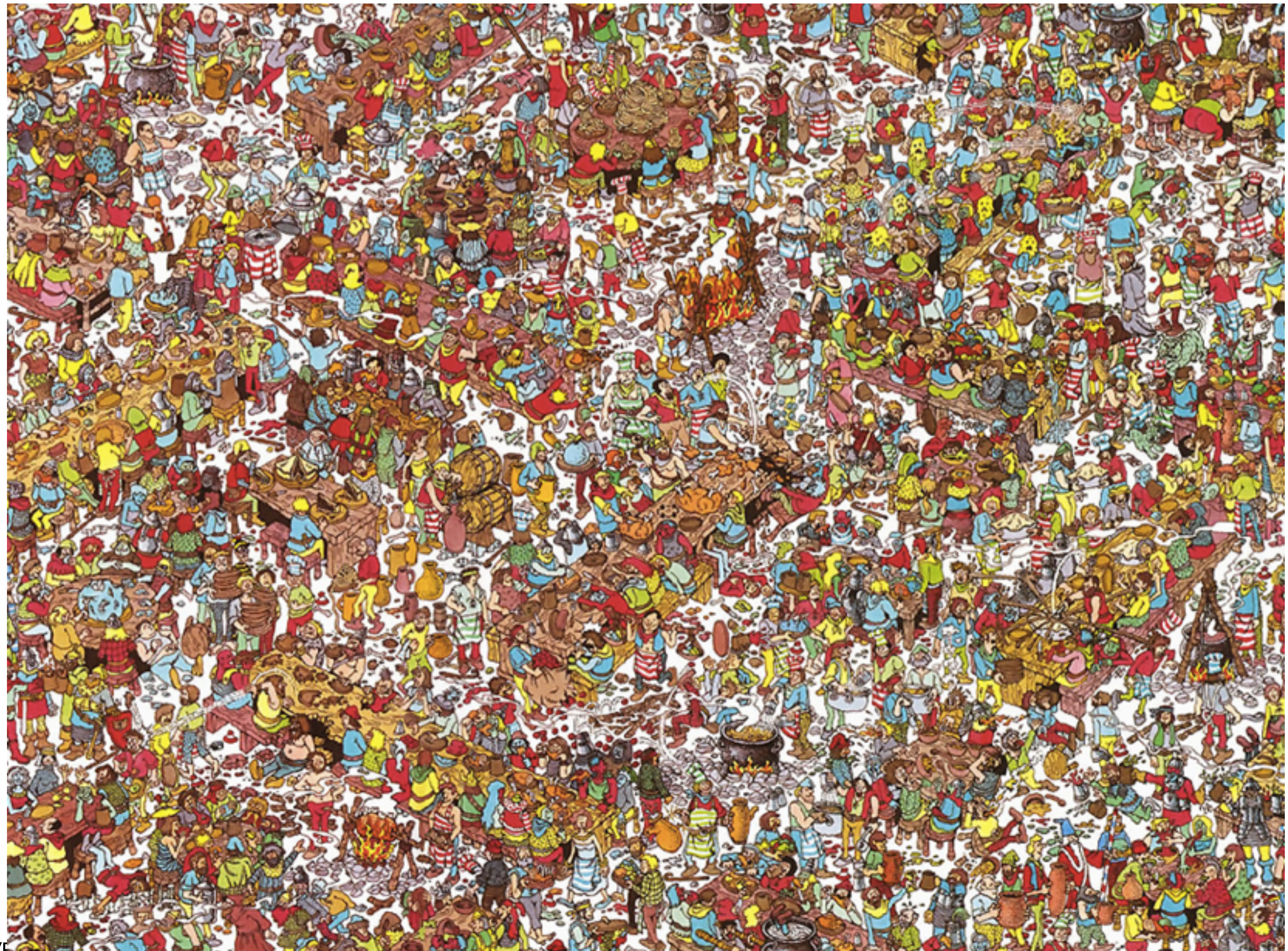
Job 3. *complete a story*

Job 4. *remember history*

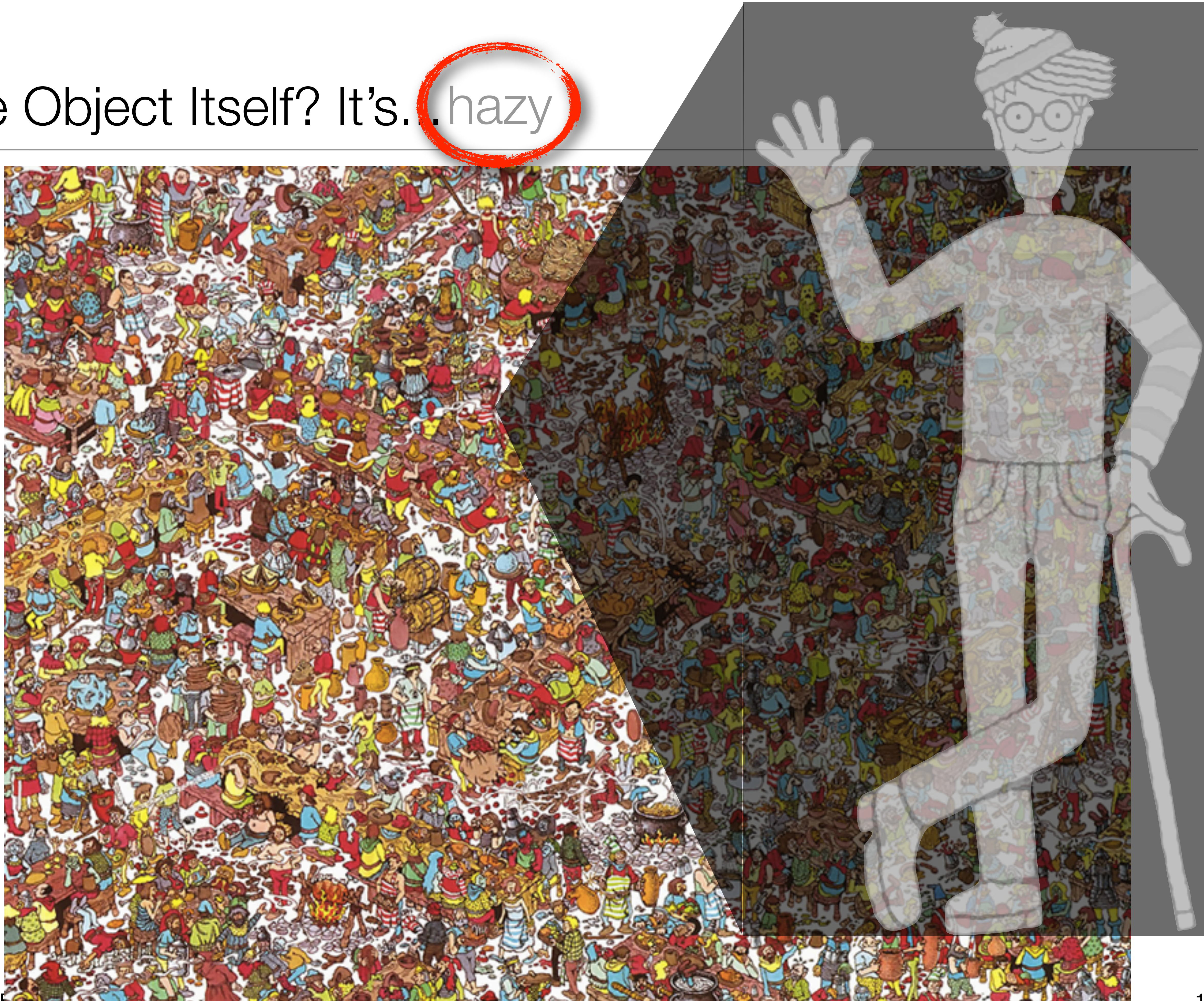
Job 1

what just happened?

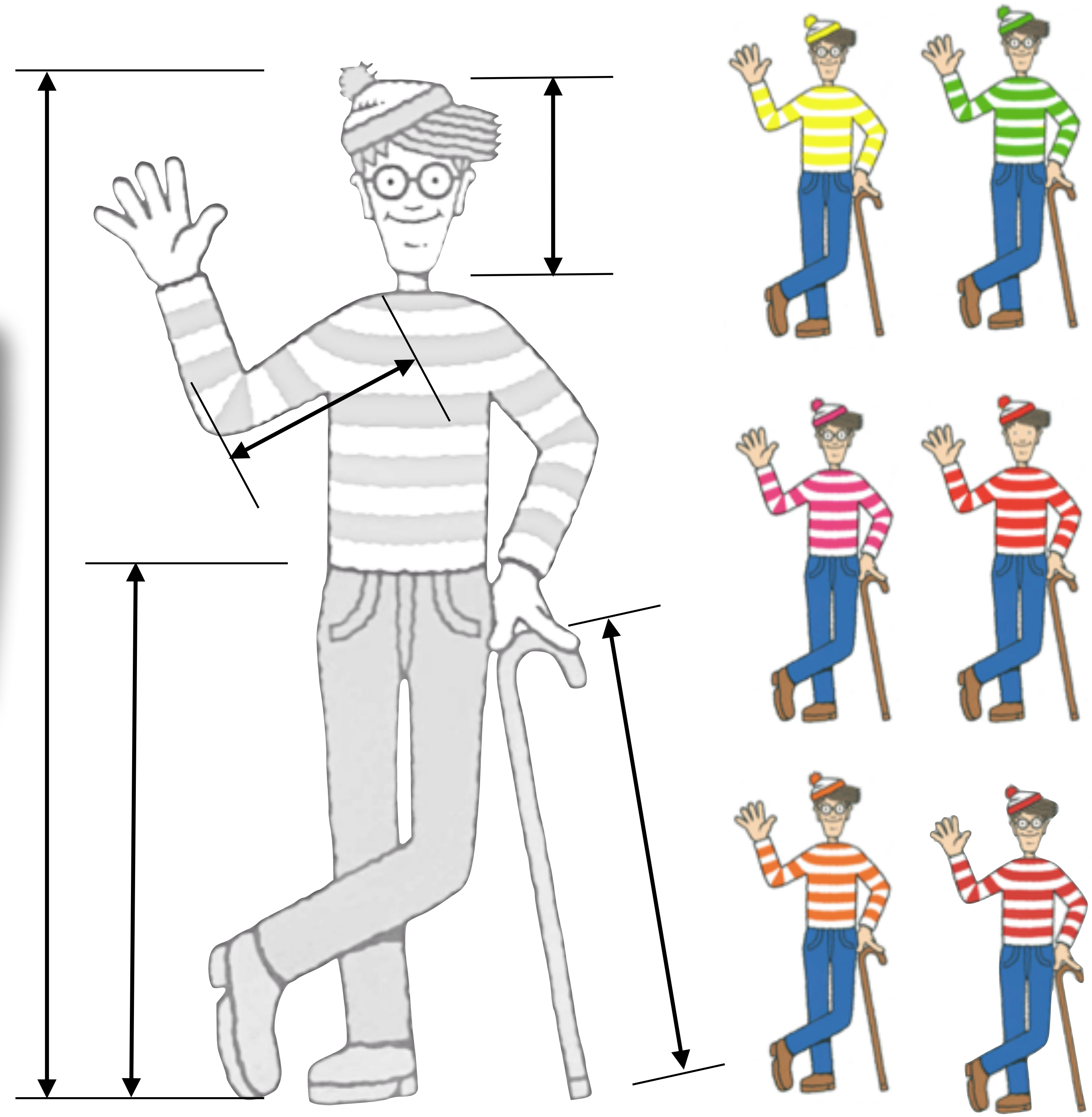
the Object Itself



the Object Itself? It’s... hazy



what's next with the Higgs-like-object?



we have to measure:

mass

spin and parity (JP) looks like J^P $0^{+,-}$?...$2^{+,-}$? mixture?

couplings to vector bosons critical

all of the couplings to fermions, esp top and tau and b

couplings proportional to mass??

all branching fractions

singlet? how many are there?

elementary?

mixing with hidden sectors?

self-interactions?

Job 2

we have hair-on-fire observational

~~problems~~, ~~disasters~~, ~~conundrums~~,

...challenges.

First, the Higgs is too light


Standard
Model

the same field theory

that in loops predicted the top mass range

and now in loops the Higgs mass range

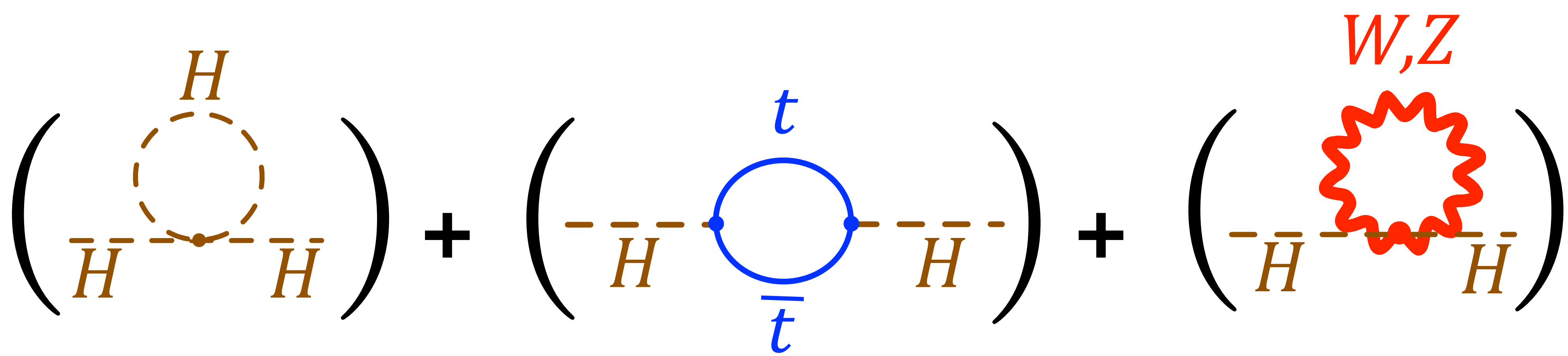
leads us to ~~trouble~~ ***opportunity***

something has to protect the mass

quadratic divergences…”naturalness problem”

better: the “Naturalness Hint”

$m_H - m_{\mathrm{bare}} =$



Taming this requires New Physics:

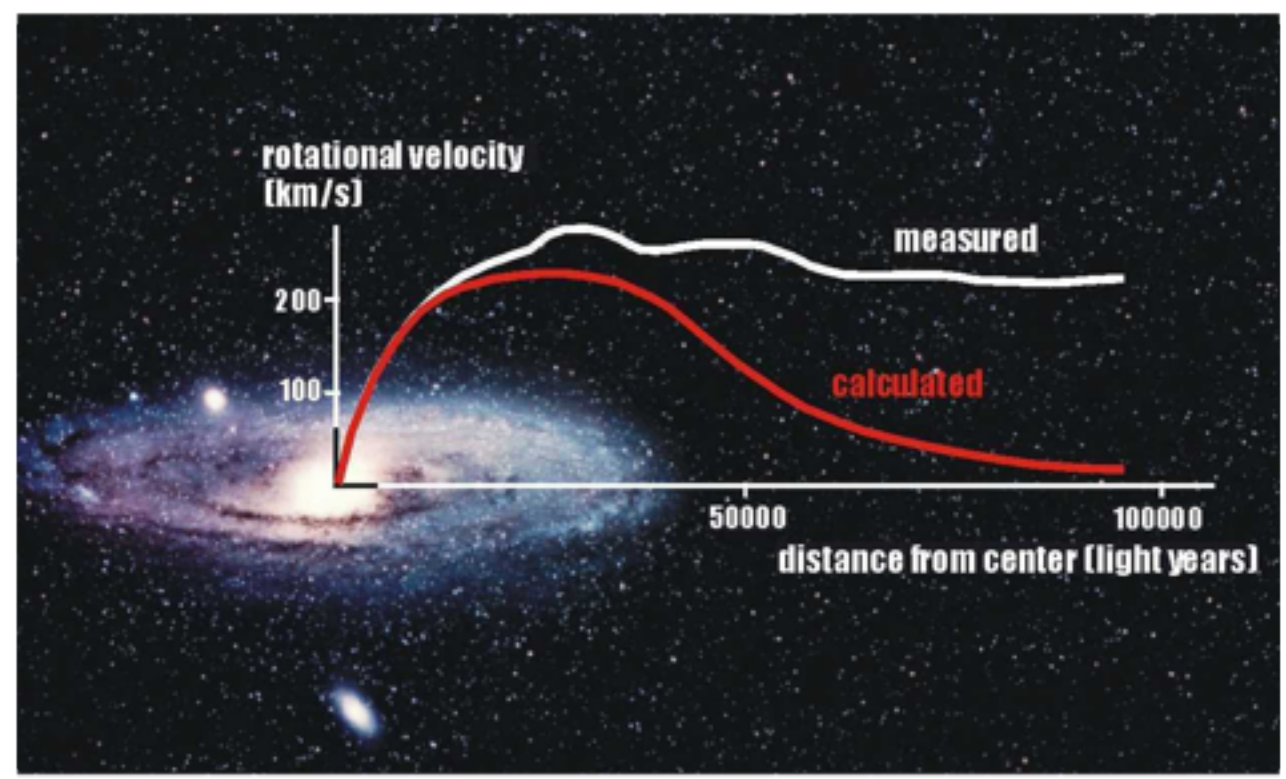
a symmetry? compositeness?

HEF job: unravel it

Second, galaxies move in ways that they shouldn't

Not like Newton

Andromeda




DARK
MATTER

since Nature’s clumpy

there has to be a Dark Matter quantum

HEF job: find it

Third, where is all of the antimatter?

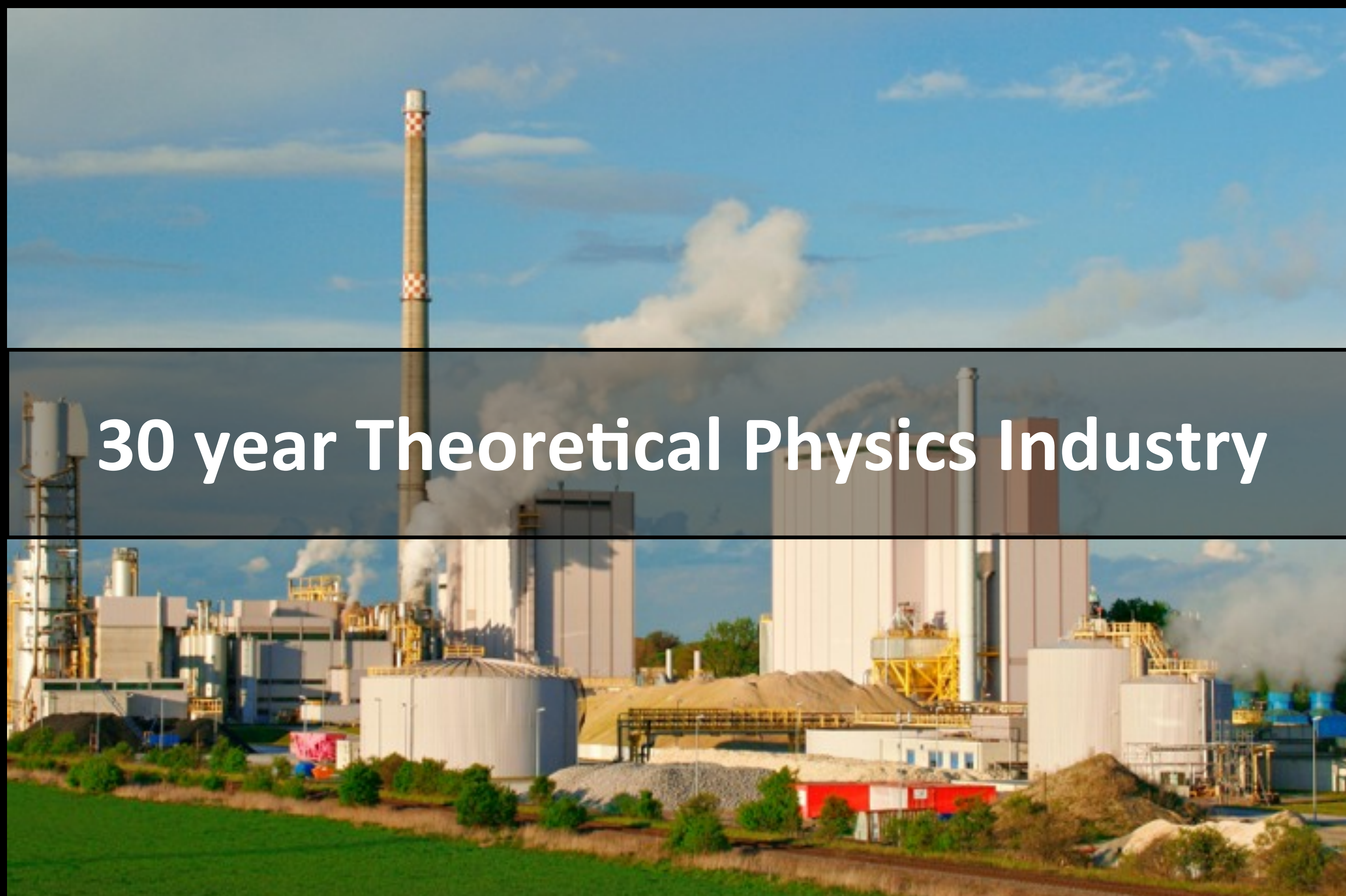
Third, where is all of the antimatter?

Some new force?

HEF job: find evidence


something
beyond
the SM!

“Beyond the Standard Model”*



* Mr Google says: 49,900,000 hits.

* Mr Google says: 49,900,000 hits.

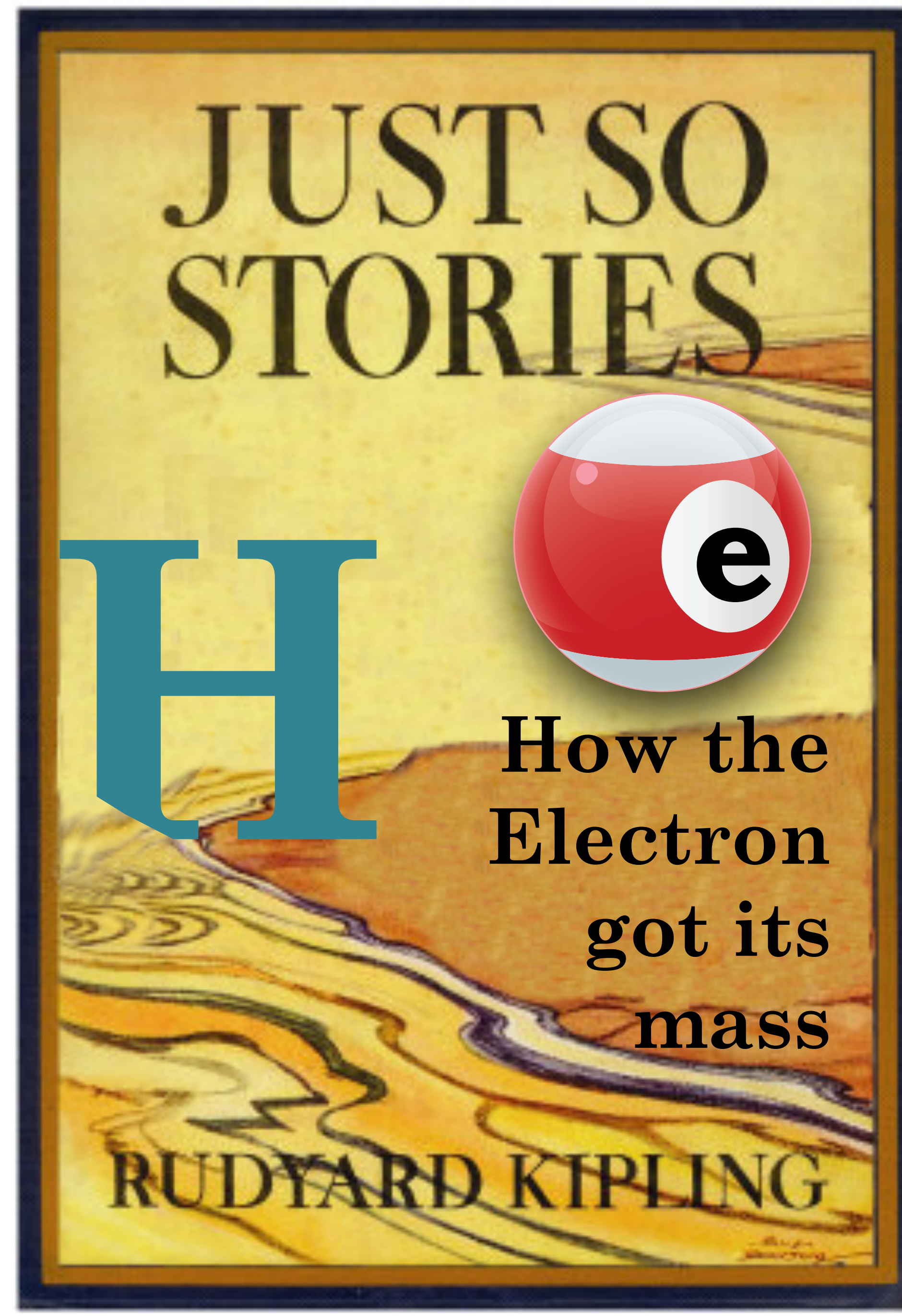
“I never said most of the things I said.

Job 3

we have a story to tell

The Standard Model didn't have to unfold so...nicely

We don't know the characters, the plot is still developing, but the storyline is gripping.

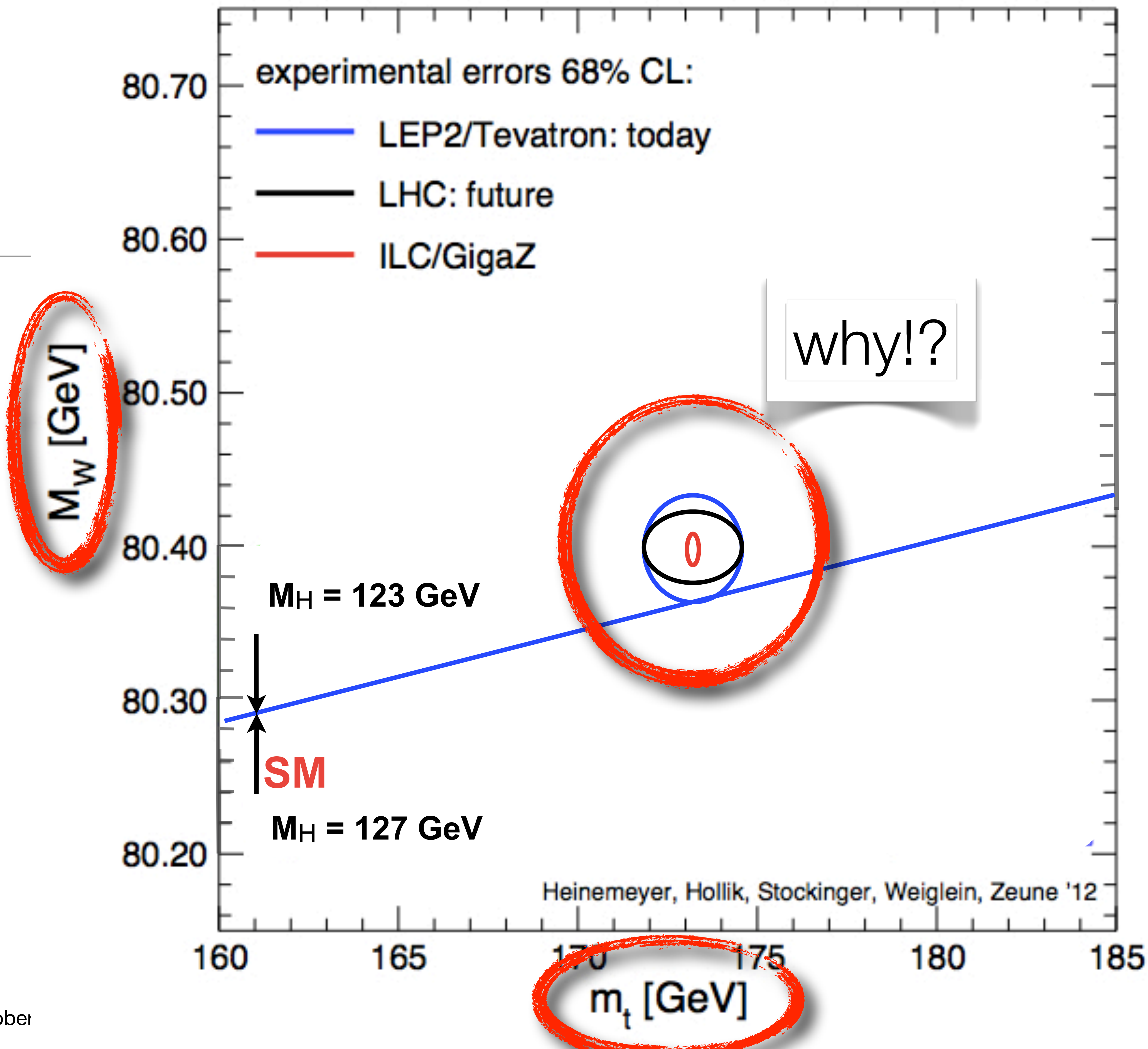


the story:

decades of work constrained the Higgs

to exactly the right place?

or *nearly* the right place?



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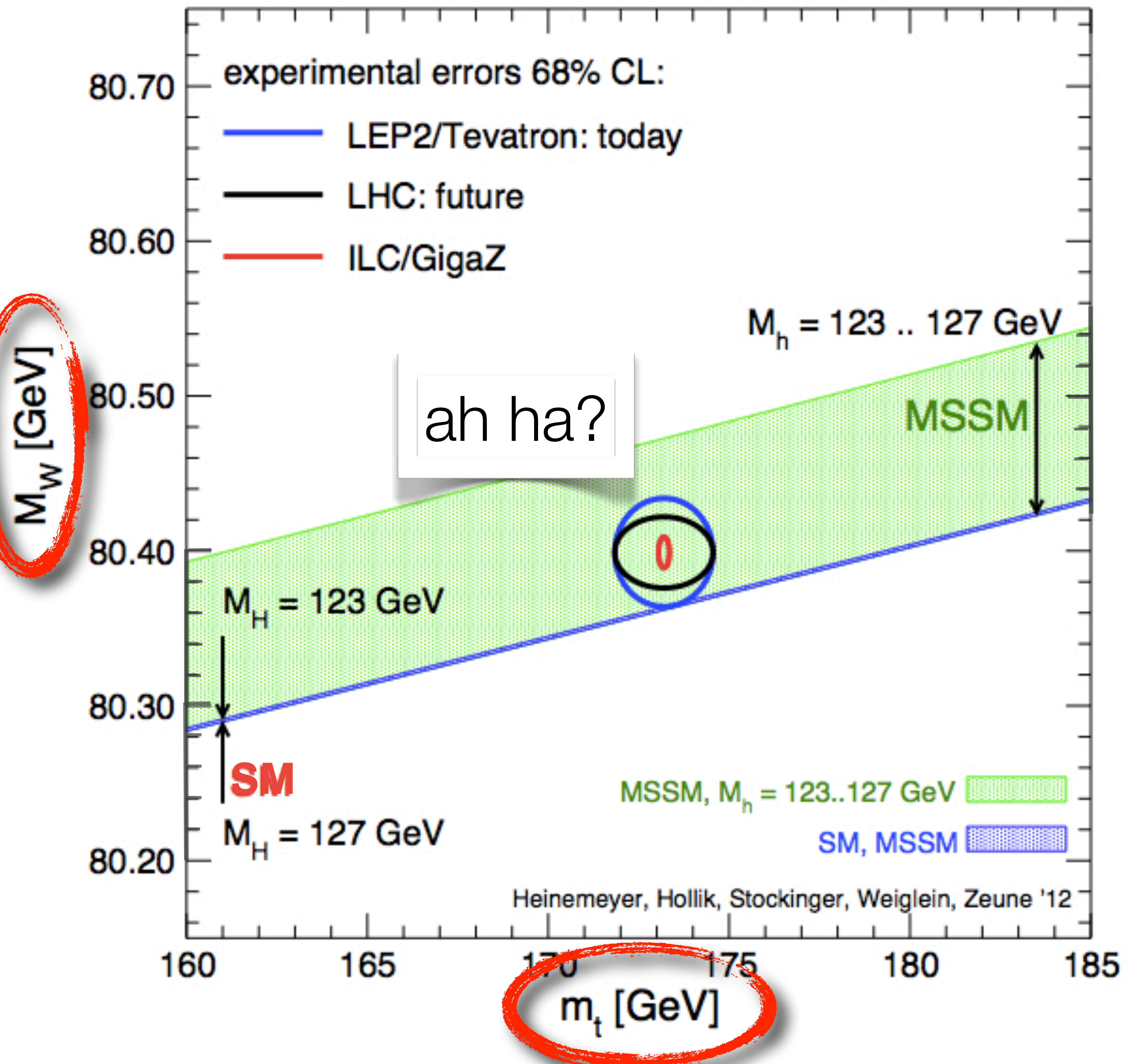


SM requires correlations among measurables

inconsistencies have to show up

HEF job: find them

Job 4

things don't always follow a roadmap!

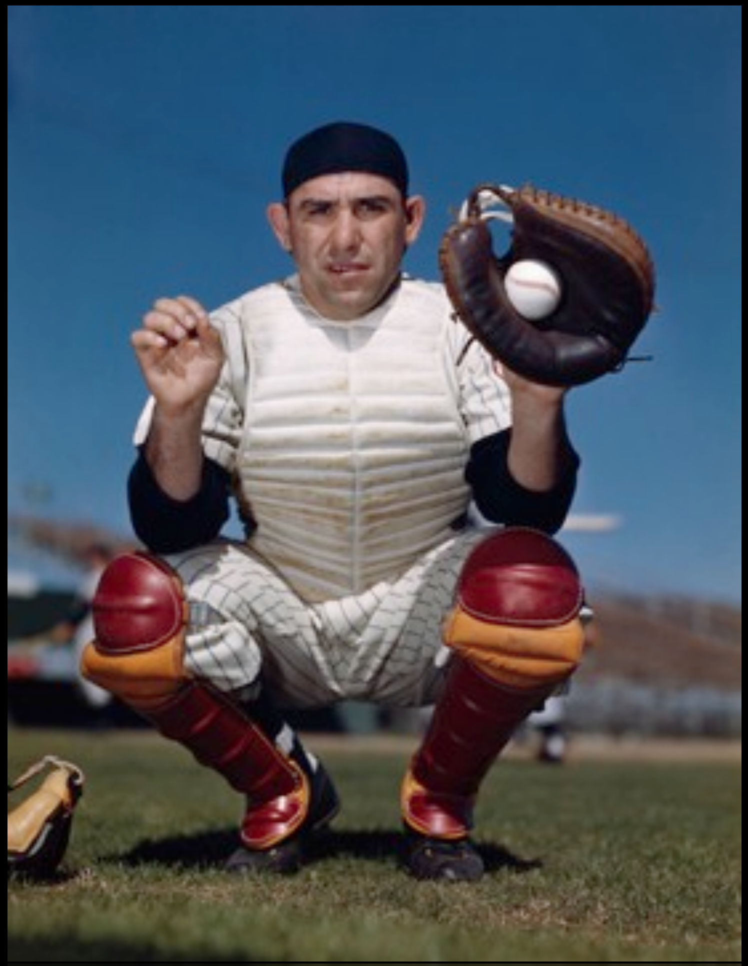
remember the:

B lifetime

muon

Charm

etc



“You've got to be very careful if you don't know where you are going because you might not get there.

Precision is the tool

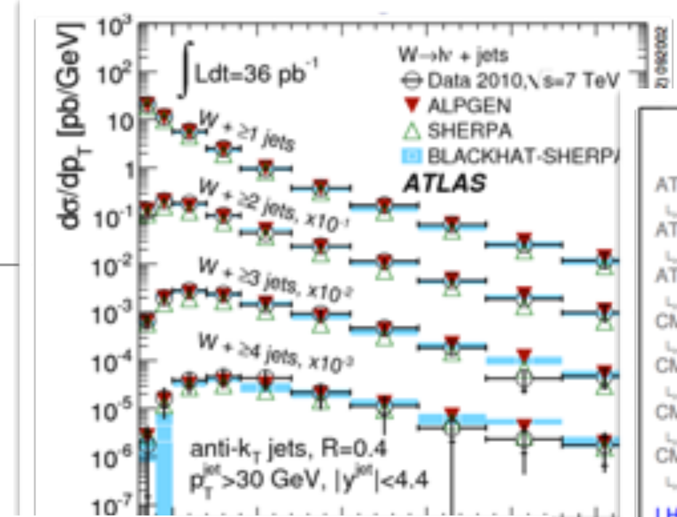
Understanding of Jets

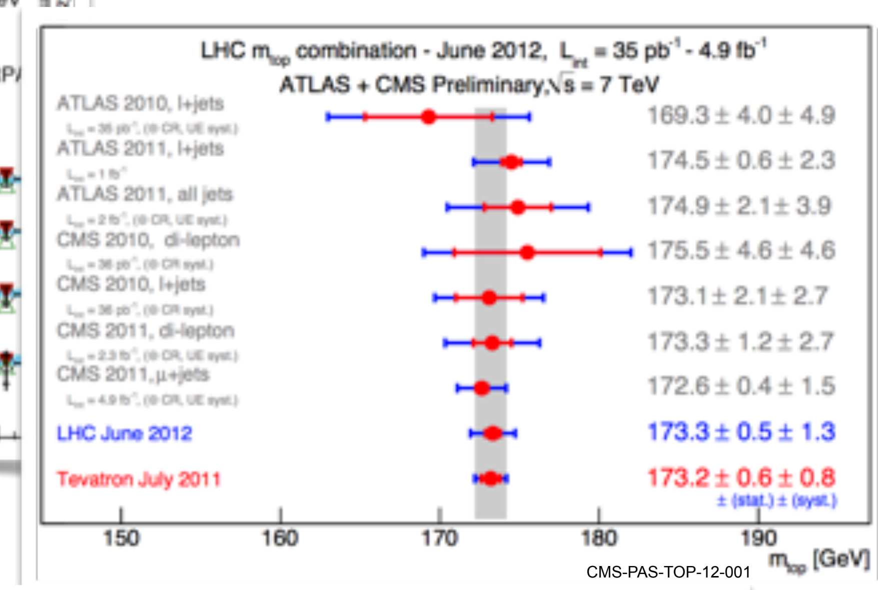
Understanding Top

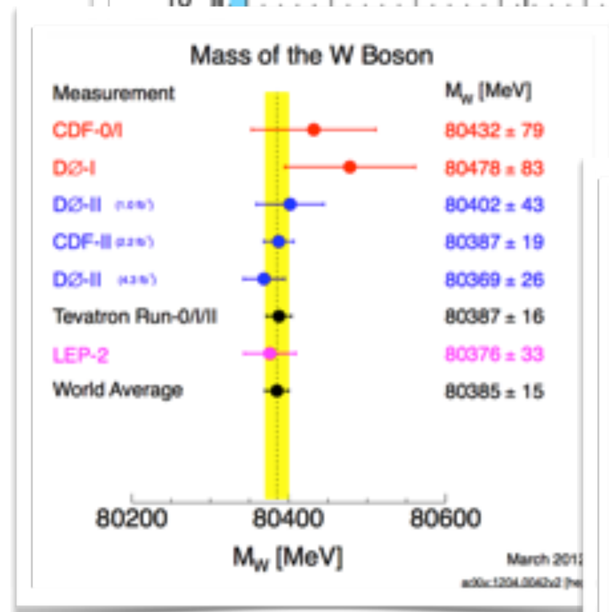
W mass

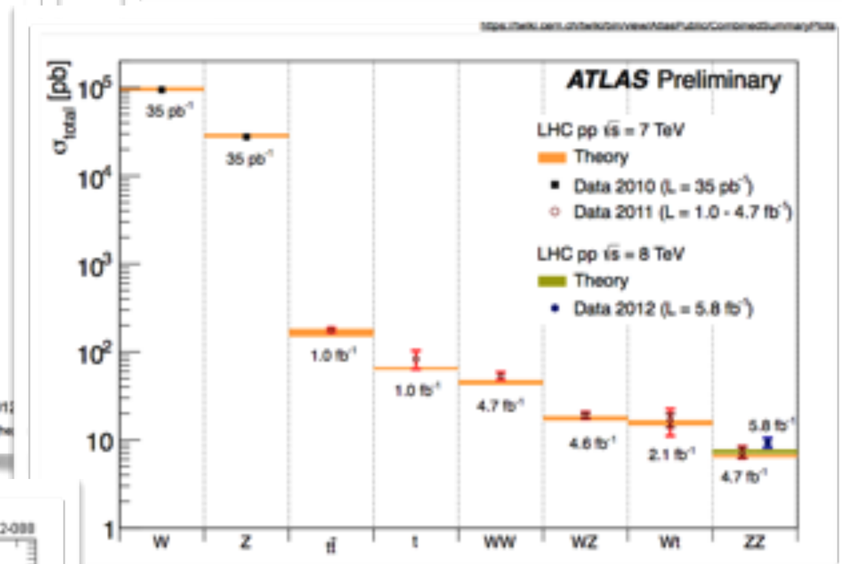
Model independent & dependent searches

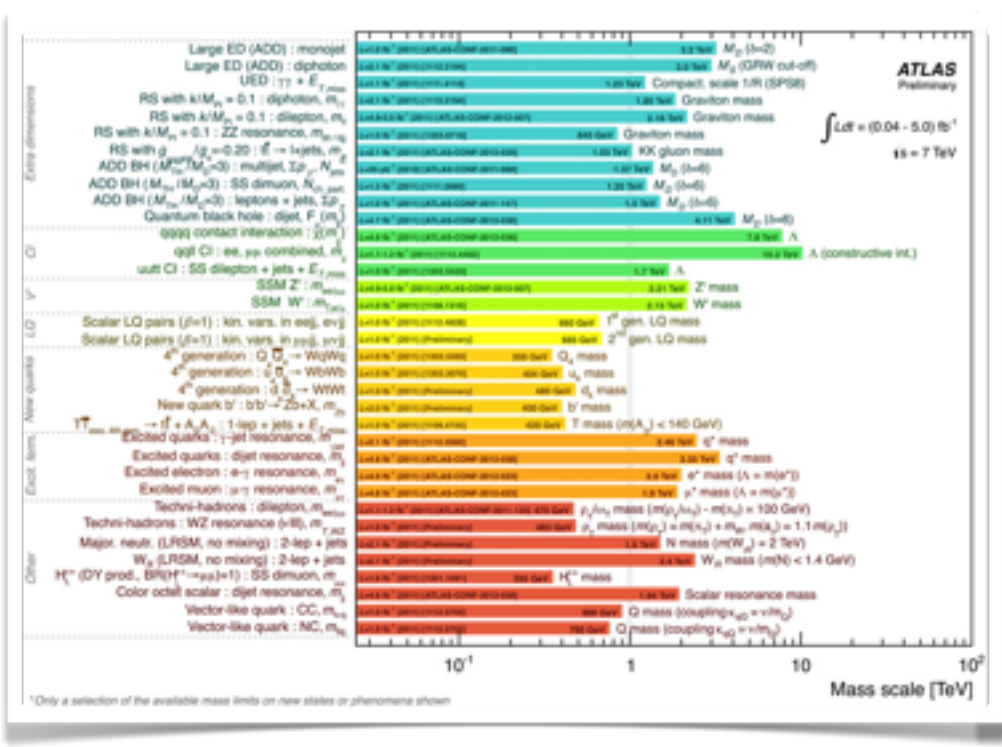
and more...and more.

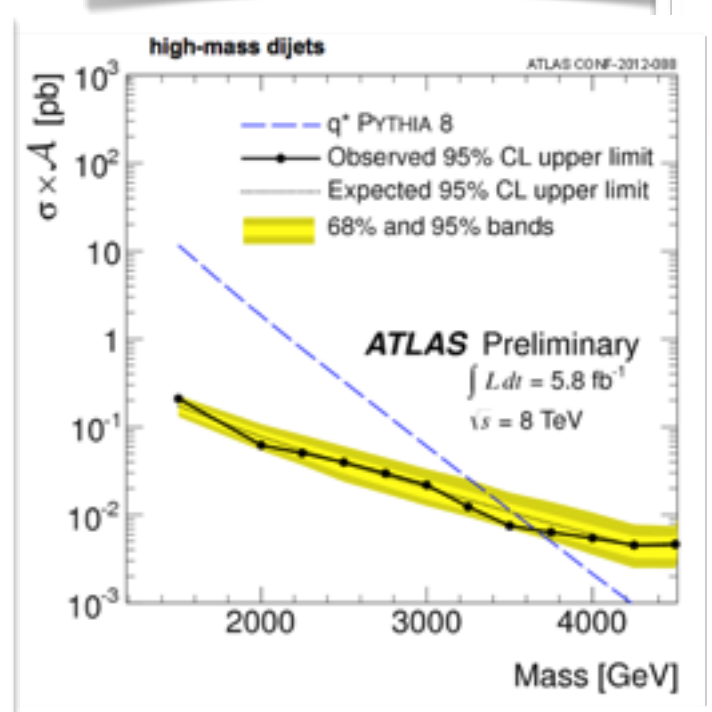


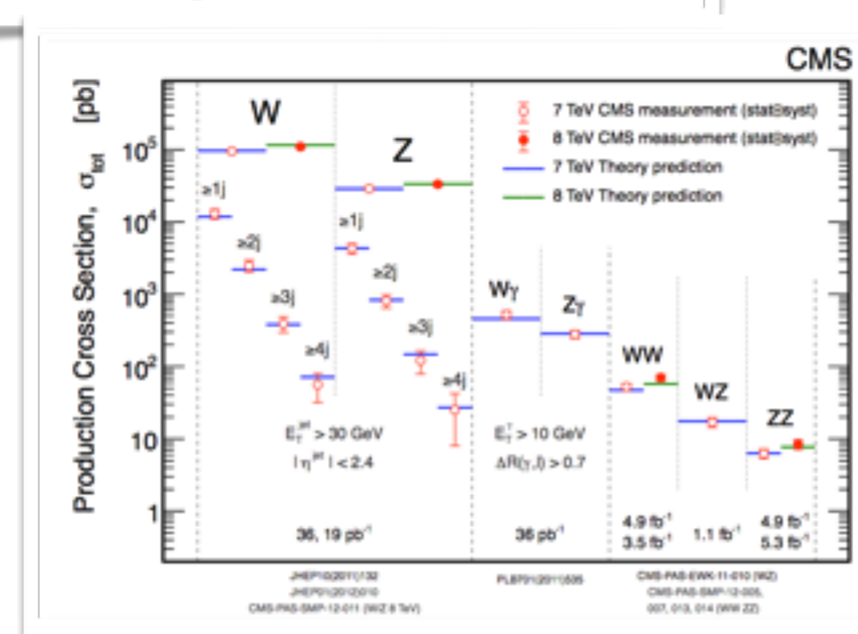












Precision

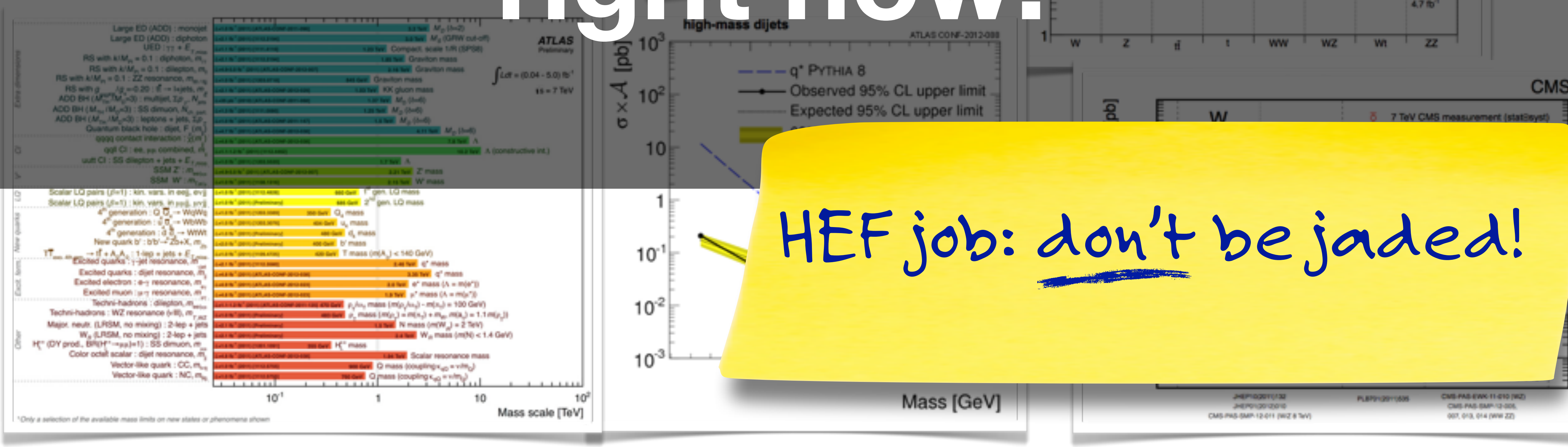
Understanding of Jets

Understanding Top

W mass

Model independent & dependent searches

and more...and more



The New Physics is hiding in these plots right now!

HEF job: don't be jaded!

So, the High Energy Frontier’s Jobs:

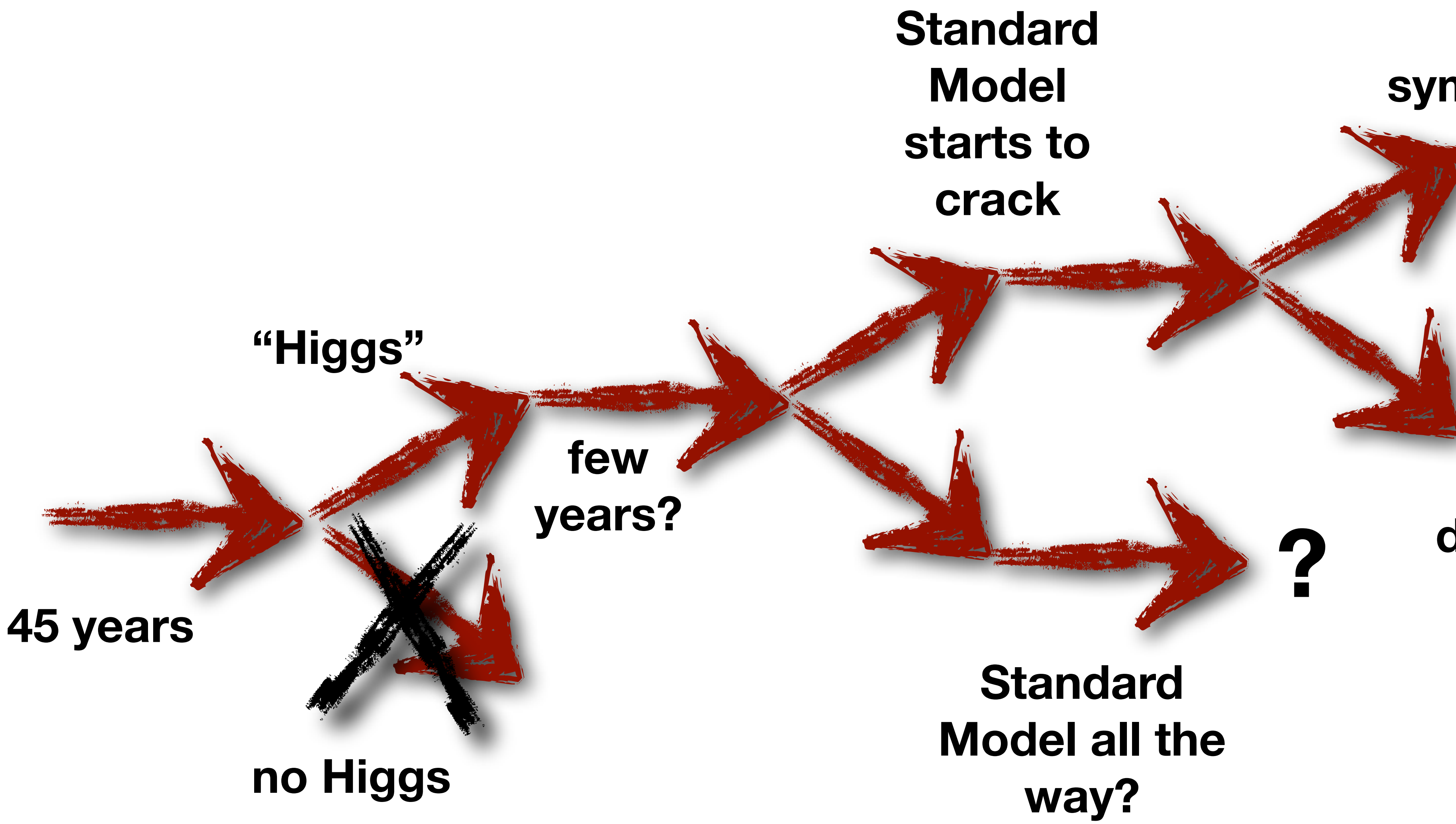
1. **Study the Higgs-like state at 125 GeV**

2. **Full-out on some troublesome questions**

3. **Write the story that encompasses the SM**

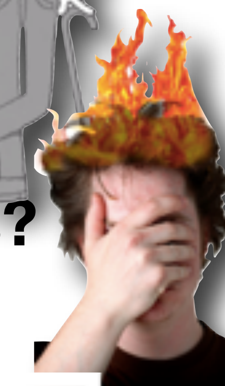
4. **Be nimble and observant to surprises**

So, it’s just getting interesting at the HEF!



new symmetries?

strong dynamics?



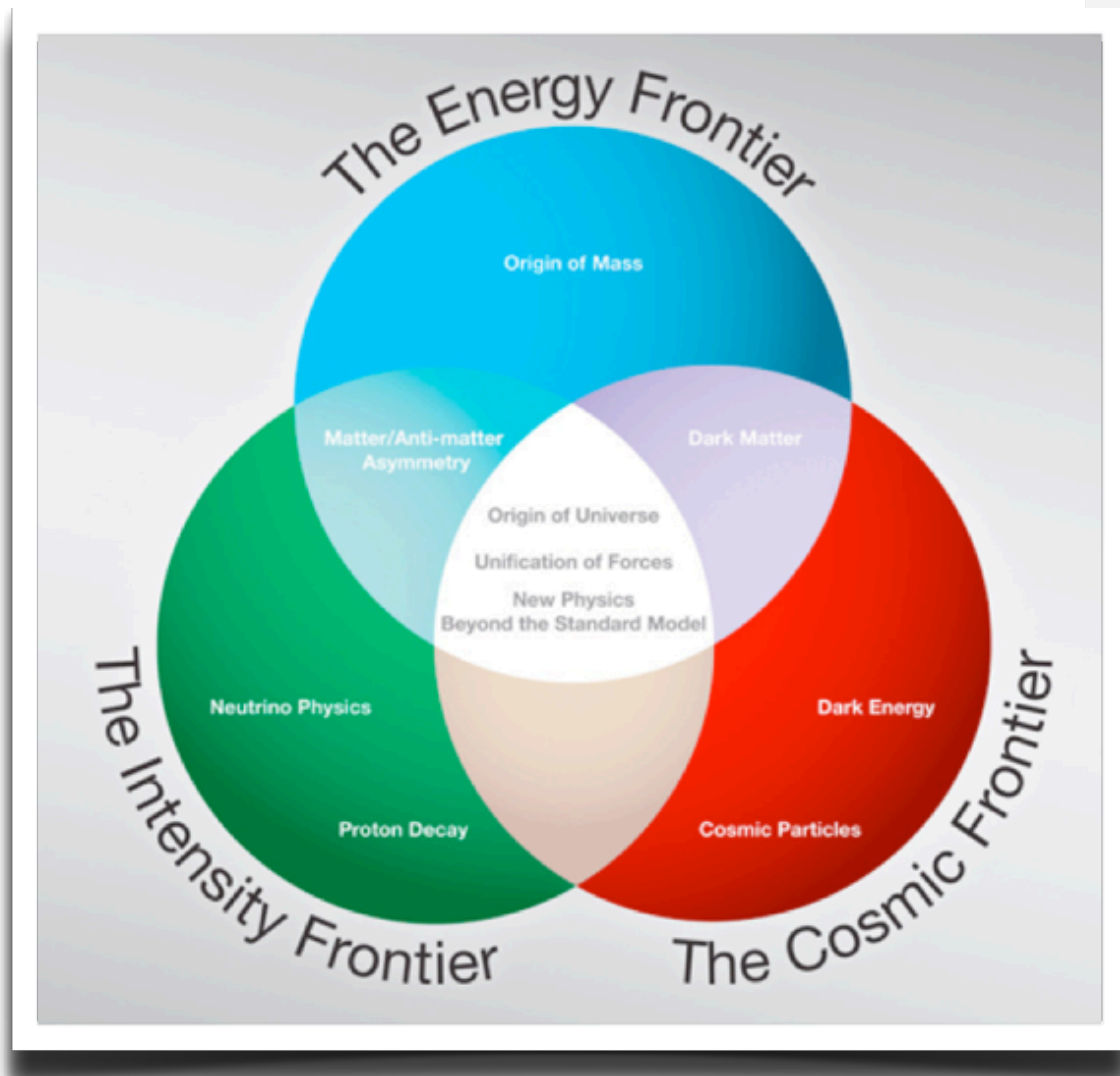
apologies to Matt Strassler

2. High Energy Frontier Study, practicalities

A gift from 2008 P5:

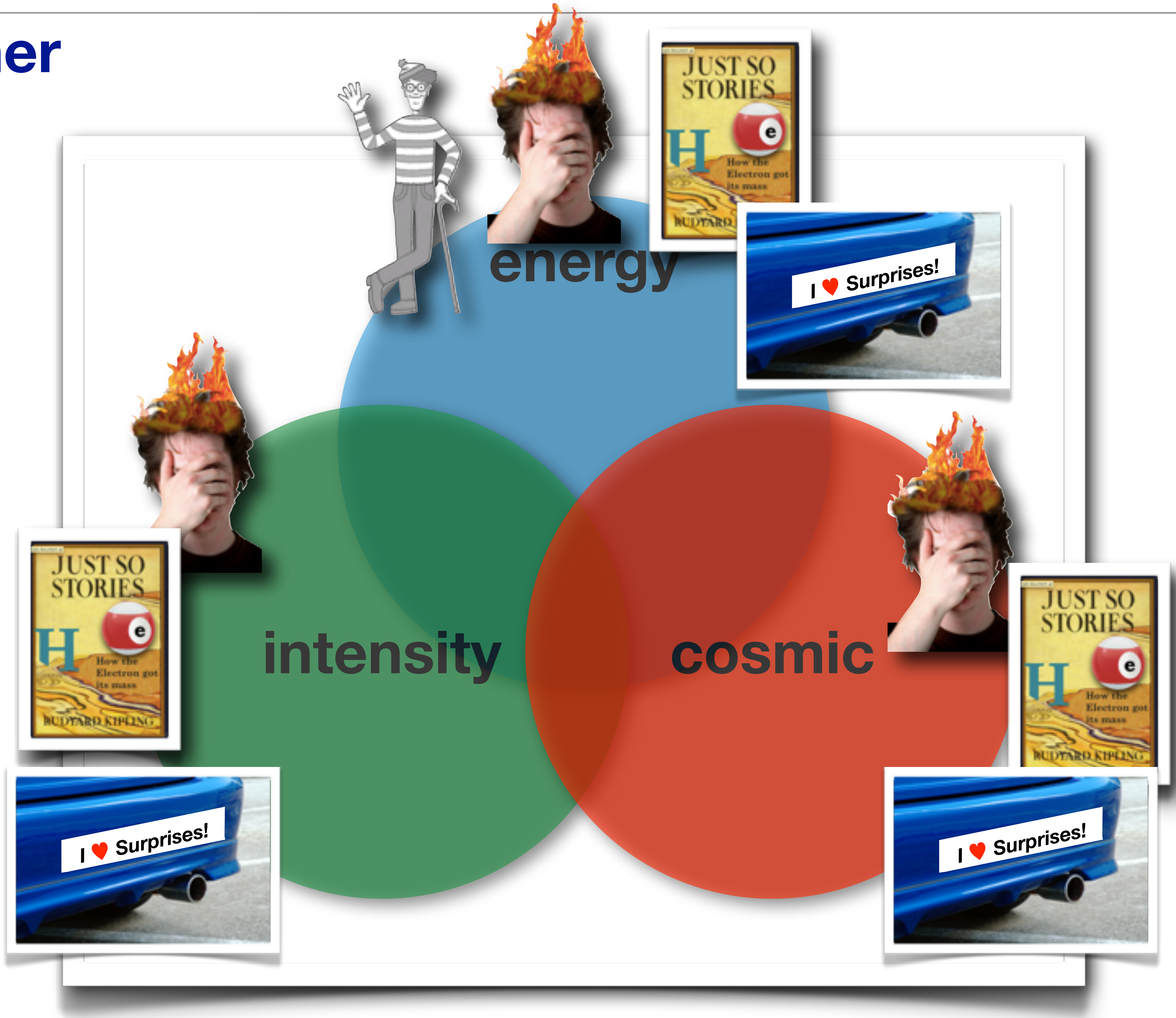
“the Frontier Circles”

and we’re organized around them



All of the Frontiers participate in the 3 jobs

together



what we've done:

Identified terrific subgroup conveners

most have been meeting together for about a month

Created necessary correlations among groups

Decided on technical "connective tissue" groups

Explicit liaisons between HEF and other frontiers

Additional group "infrastructure"

established direct connection with the established collaborations:

"Contacts and consultants": ATLAS: Paul Tipton; CMS: Jim Olsen; LHCb: Sheldon Stone; ILD: Graham Wilson; SiD: Andy White;CLIC: Mark Thomson; Muon Collider: Ron Lipton

High Energy Frontier working groups

HE1: The Higgs Boson

Jianming Qian (Michigan), Andrei Gritsan (Johns Hopkins), Heather Logan (Carleton), Rick Van Kooten (Indiana), Chris Tully (Princeton), Sally Dawson (BNL)

HE2: Precision Study of Electroweak Interactions

Michael Schmitt (Northwestern), Doreen Wackeroth (Buffalo), Ashutosh Kotwal (Duke)

HE3: Fully Understanding the Top Quark

Robin Erbacher (Davis), Reinhard Schwienhorst (MSU), Kirill Melnikov (Johns Hopkins), Cecilia Gerber (UIC), Kaustubh Agashe (Maryland)

HE4: The Path Beyond the Standard Model–New Particles, Forces, and Dimensions

Daniel Whiteson (Irvine), Liantao Wang (Chicago), Yuri Gershtein (Rutgers), Meenakshi Narain (Brown), Markus Luty (UC Davis)

HE5: Quantum Chromodynamics and the Strong Interactions

Ken Hatakeyama (Baylor), John Campbell (FNAL), Frank Petriello (Northwestern), Joey Huston (MSU)

HE6: Flavor Physics and CP Violation at High Energy

Soeren Prell (ISU), Michele Papucci (LBNL), Marina Artuso (Syracuse)

HEF Goals:

1. **In light of circa 2013 results what physics can be achieved before ~2018**

   ...at design specifications with $\int\mathcal{L}\, dt$ ~100 fb^{-1})?

2. **What are the LHC high luminosity physics goals for**

   ..."Phase 1": circa 2022 with $\int\mathcal{L}\, dt$ of approximately 400 fb^{-1}

   ..."Phase 2": circa 2030 with $\int\mathcal{L}\, dt$ of approximately 3000 fb^{-1}

   How do the envisioned upgrade paths inform those goals?

   Specifically, to what extent is precision Higgs Boson physics possible?

3. **Does a Higgs Boson @ ~125 GeV/c^2 call for a "Higgs Factory"?**

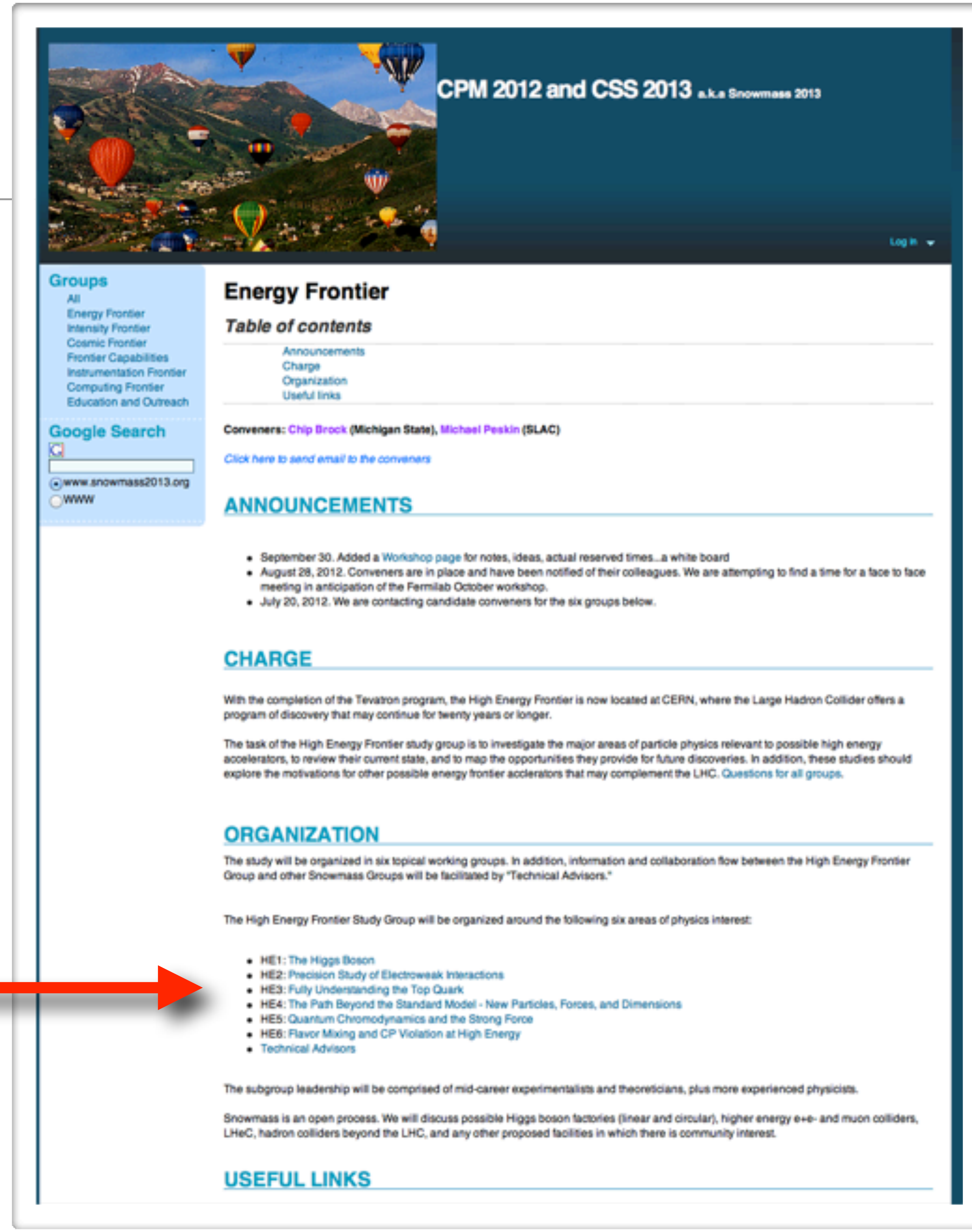
4. **What are the physics cases for accelerators beyond 2025?**

   High energy LHC? High energy lepton collider? Lepton-hadron collider? VLHC?

We too have a wiki

http://www.snowmass2013.org

increasingly active



find each group's detailed charges

"You can observe a lot just by watching.

Candidate scenarios to be addressed by all groups:

A. *The LHC with $E = 14$ TeV and $L = 10^{34}$ cm^{-2} sec^{-1}* ✔ ✔ ✔ ✔

B. *A luminosity upgraded LHC with: $E_{cm} = 14$ TeV, $L = \sim 10^{35}$ cm^{-2}s^{-1}* ✔ ✔ ✔

C. *An energy upgraded LHC* !

D. *e+e- lepton colliders $E_{cm} < \sim 1$ TeV* ✔ ✔ ✔

E. *A circular e+e- collider operating as a Higgs factory.* !

F. *e+e- or gamma-gamma collider $E_{cm} > \sim 1$ TeV* ✔ ✔

G. *A mu+mu- collider.* ✔

H. *A lepton-hadron collider.* ✔

I. *A VLHC hadron collider with energy well above the LHC energy.* ✔

- *It is important to point out critical points in energy or luminosity that are essential to realize physics goals.*
- *For experiments at hadron colliders, a specific question is the effect of the machine environment for high-luminosity running. Do high-luminosity conditions compromise the needed measurements? Are there detector designs or experimental strategies that can ameliorate these problems?*

operational: ✔ ✔ ✔ ✔	engineered: ✔ ✔ ✔	under study: ✔
well engineered: ✔ ✔ ✔	well studied: ✔ ✔	gleam in someone's eye: !

Common template Charge to each HEF Group:

1. **Please provide a compact summary of the state of the search for X physics, including information from LEP, the Tevatron, and the LHC.**

2. **Please address the following goals for X physics in the future:**

- **...tailored list of questions/goals follow**

3. **Please guide your exploration of the above goals with the following scenarios/caveats:**

- Evaluate the above goals in the context of Candidate Facilities A-I. (Collaboration with the Facilities Frontier is expected.)
- Are new theoretical or simulation tools (for signal or backgrounds) required in order to achieve the goals?
- What are the detector and computing challenges that the above goals imply? (Collaboration with the Instrumentation and Computing Frontiers is expected.)

an expurgated version

of their charges

Charge to the group,
The Higgs Boson:

- **How will we measure the full phenomenological profile of the Higgs boson?**
- **What level of precision can be achieved at the various proposed accelerators?**
- **What are the unique capabilities of each program?**
- **How will we discover possible additional states in the Higgs sector?**
- **To what extent are properties of the Higgs sector important more generally for fundamental physics?**

Charge to the group,
Precision Study of Electroweak Interactions:

- **What are the most important precision observables that will be studied at proposed accelerators?**

- **What level of precision can be achieved, and what is the importance of these measurements?**

- **How well can we probe the couplings of the W and Z bosons?**

- **What do we hope to learn from these measurements?**

Charge to the group,

Fully Understanding the Top Quark:

- **How well can we measure the top quark mass and width at proposed accelerators?**
- **How well can we measure the couplings of the top quark?**
- **How deeply can we probe for rare decays of the top quark?**
- **How can we use these measurements to search for new physics?**
- **Are there new particles that decay to top? How can we find them?**

Charge to the group,

The Path Beyond the Standard Model:

- What is the new picture of physics at the TeV scale including the new information from LHC?
- Can electroweak symmetry breaking still be "natural"? What does this imply?
- What types of new particles might be found at the various proposed accelerators?
- Are there more effective strategies to discover Supersymmetry, Composite Higgs, and other proposed models?
- How can accelerator experiments help to address the problem of dark matter?

Charge to the group,
Quantum Chromodynamics and the Strong Interactions:

- **How can we improve the precision of our understanding of the strong interactions in perturbative QCD, in parton distributions, in non-perturbative physics?**

- **How do we incorporate electroweak interactions into precision QCD?**

- **How can QCD concepts such as jet substructure be used as tools for experimental discovery?**

Charge to the group,
Flavor Physics and CP Violation at High Energy:

- **What are the viable models of TeV scale physics that include flavor non-universality and CP violation?**

- **What new particles or new signatures are implied by these theories? How will we discover them?**

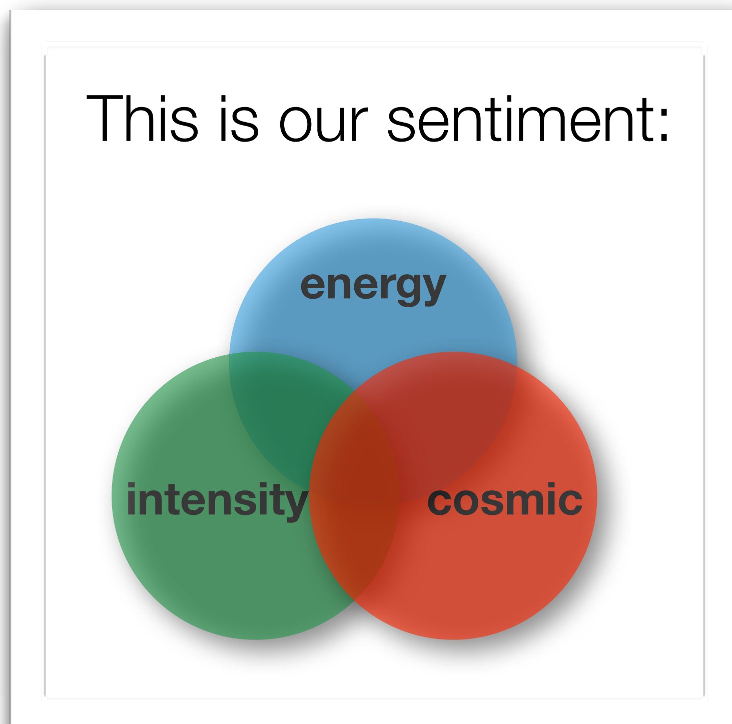
- **How can high energy hadron colliders uniquely search for new physics in b and tau decays?**

the overlaps

2 kinds of overlaps

Facilities, Instrumentation, and Computing Frontiers

Other Physics Frontiers groups



“technical group”

An explicit interface between the HEF physics groups and the FF, IF, and CF groups

Technical Group:

Beate Heinemann (Cal), Tom LeCompte (ANL), Jeff Berryhill (FNAL), Eric Torrence (Oregon), Tor Raubenheimer (SLAC), Eric Prebys (FNAL)

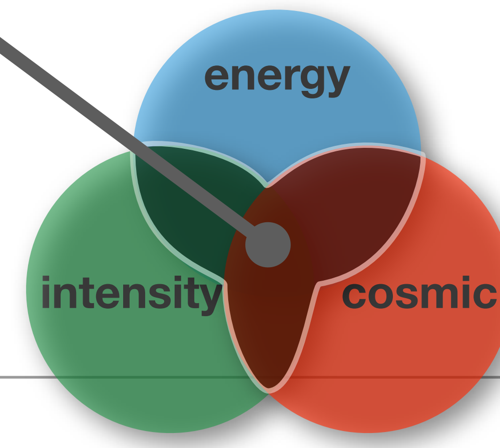
Early in the new year:

Establishing common benchmark parameters for each Candidate Facility

in support of the physics groups

Throughout the spring and workshop:

Liaison with the Facilities, Instrumentation and Computing Frontier Groups this part!



Physics overlaps

Explicit dual-coverage conveners:

HEF & CF (Dark Matter): *Lian-Tao Wang & Konstantin Matchev*

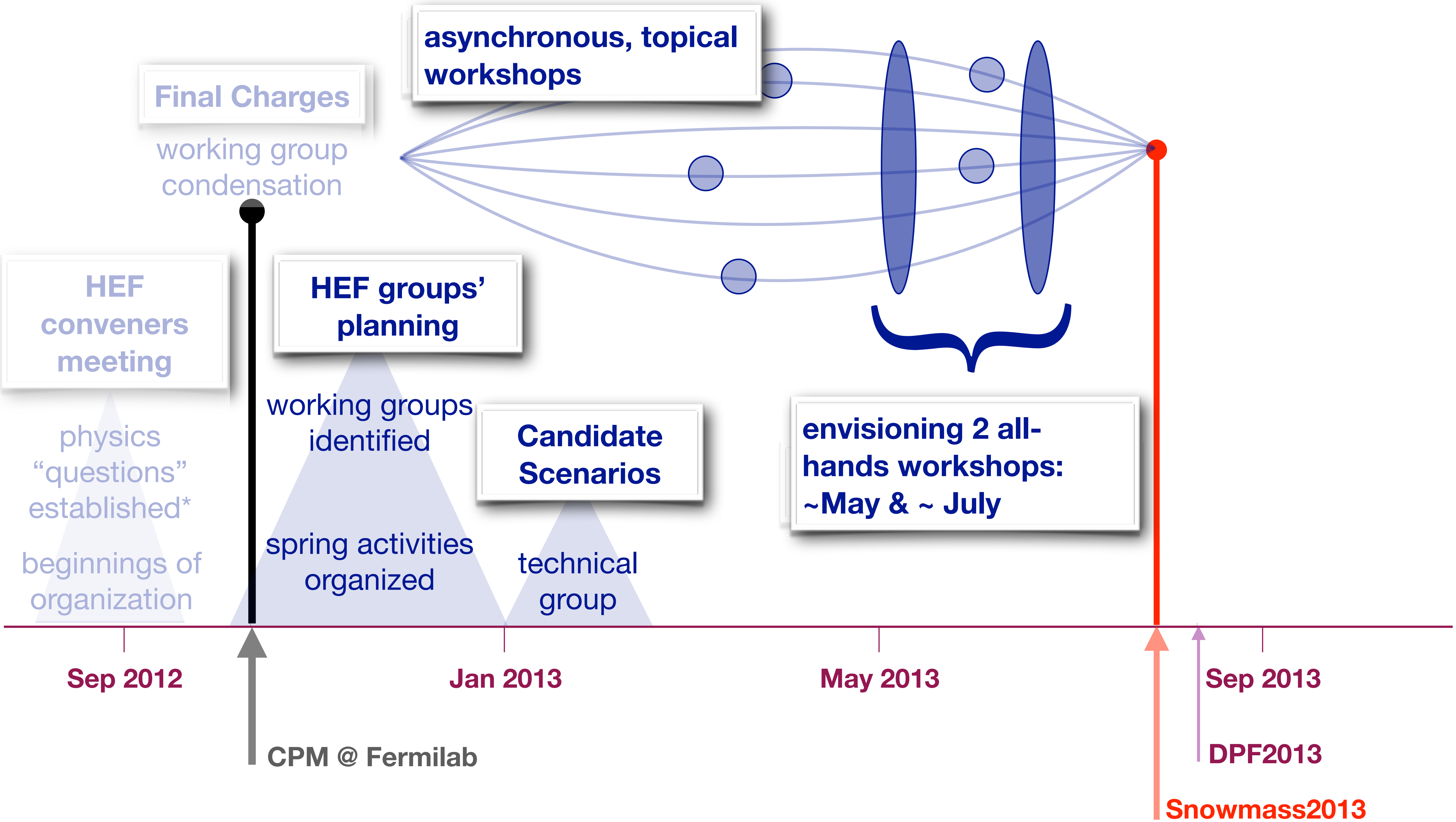
HEF & CF (Baryogenesis): *Michele Papucci & Ann Nelson*

HEF & HIF (b physics): *Michele Papucci & Zoltan Ligeti*

3. What’s next for the High Energy Frontier

our to-do list

1. work.



4. This meeting: A full agenda for Friday

You're asking yourself:
"How do I get involved?"

Attend these meetings!

HEF Agenda for Friday, October 12th

During the day: The Auditorium

Subgroup Conveners will present

plans, organization, projects for study

orientation to future colliders and challenges for experimentation

During the evening (19:30 - 21:00)

Six parallel working meetings, including some joint meetings

ReadyTalk is available for all meetings.

During the Day: The Auditorium

Friday Morning

S1: 09:30 - 10:30 Landscape of Future Colliders

(joint HEF/Facilities)

Eric Prebys (FNAL): Hadron Colliders (15 + 5)

Mark Palmer (FNAL): Lepton Colliders (15+5)

Eric Torrence (Oregon): Physics Simulation for Hadron and Lepton Colliders (15+5)

S2: 10:45 - 11:45 Higgs / Electroweak

Chris Tully (Princeton): Higgs Physics at Hadron Colliders (15 + 5)

Rick Van Kooten (Indiana): Higgs Physics at Lepton Colliders (15 + 5)

Ashutosh Kotwal (Duke): Electroweak Physics after the Higgs Discovery (15+5)

S3: 12:00 - 13:00 Top / QCD

Joey Huston (Michigan State): Major Issues in QCD (25+5)

Reinhard Schwienhorst (Michigan State): Top quark physics (25+5)

(no break for lunch!)

During the Day: The Auditorium

Friday Afternoon

S4: 13:15 - 14:15 Challenges for Future Experiments

(joint HEF/Instrumentation/Computing)

Ulrich Heintz (Ohio): Detector Challenges for Future Hadron Colliders (15+5)

Andy White (UT Arlington): Detector Challenges for Future Lepton Colliders (15+5)

Ian Fisk (FNAL): Computing Challenges and Opportunites in the Next Decade (15+5)

S5: 14:30 - 15:30 New Particles / Flavor

Yuri Gershtein (Rutgers): What are the options for search strategies; how do we evaluate them? (5)

George Redlinger (BNL): Future of the search for supersymmetry at colliders (15)

Paddy Fox (FNAL): Future of the search for composite Higgs models and related exotic particles at colliders (15)

Michele Papucci (LBNL): Flavor Physics and CP violation at high energy (25)

During the Evening: Parallel Sessions

Friday Evening

19:30 - 21:00 **New Particles, Daniel Whiteson**

WH3NE (THEORY)

Informal discussion of new particle searches: What studies should be done, how do we cooperate between groups, what should the final product be?

19:30 - 21:00 **Flavor, Soeren Prell**

WH3NW (Conjectorium)

Informal discussion of Flavor Physics and CP violation at high energy: What are the important topics to study?

During the Evening: Parallel Sessions

Friday Evening

19:30 - 21:00 **Top Quark, Reinhard Schwienhorst**

WH7W (Racetrack)

19:30 - 20:00	Discussion of precision top physics (leaders: Gerber + Melnikov)
20:00 - 20:30	Discussion of detector physics involving top (leader: Schweinhorst)
20:30 - 21:00	Discussion of new physics involving top (leaders: Erbacher and Agashe)

19:30 - 21:00 **QCD, Joey Huston**

WH10W (WestWing)

19:30 - 20:00	Introduction and general overview; connections with other efforts, such as Les Houches (Huston)
20:00 - 20:30	Discussion of leading questions and issues related to QCD at present and future colliders
20:30 - 21:00	Joint discussion with Electroweak group (leader: Petriello)

During the Evening: Parallel Sessions

Friday Evening

19:30 - 21:00 **Higgs, Chris Tully**

WH11NE (Sunrise)

19:30 - 21:00 Informal discussion of studies to be done on hadron and lepton collider strategies for Higgs studies

19:30 - 21:00 **Electroweak, Michael Schmitt**

WH11SE (RoundTable)

19:30 - 19:50 discussion of future electroweak precisions measurements (leader: Ashutosh Kotwal)

19:50 - 20:10 Discussion of W and Z trilinear and Quartic couplings (leader: Michael Schmitt)

20:10 - 20:30 Discussion of Electroweak fits including Higgs (leader: Doreen Wackeroth)

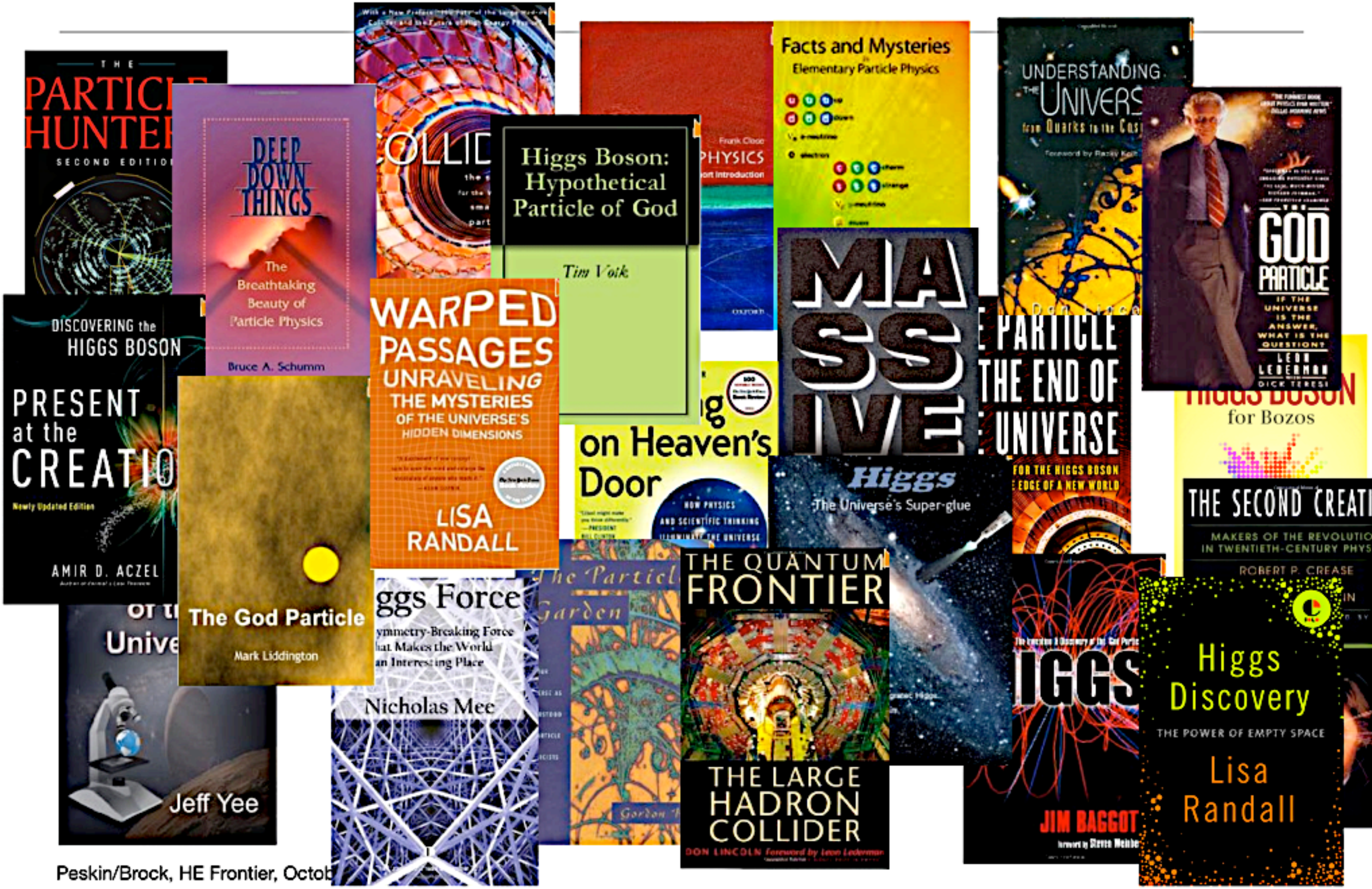
20:30 - 21:00 joint with QCD....go to WH10W

astonishingly

The world followed the Higgs Boson saga

that’s a big responsibility

a literature explosion that even astronomers envy

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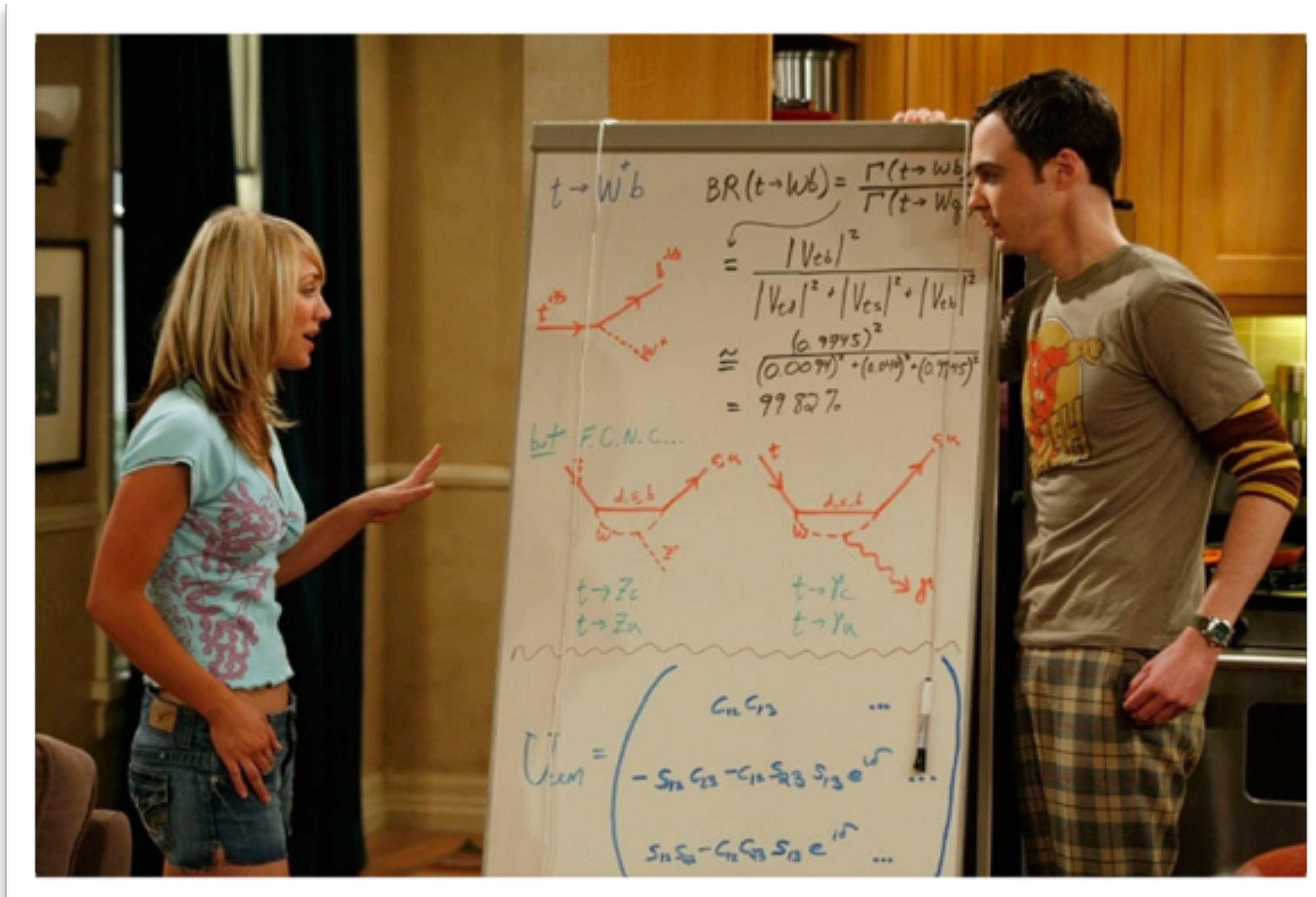
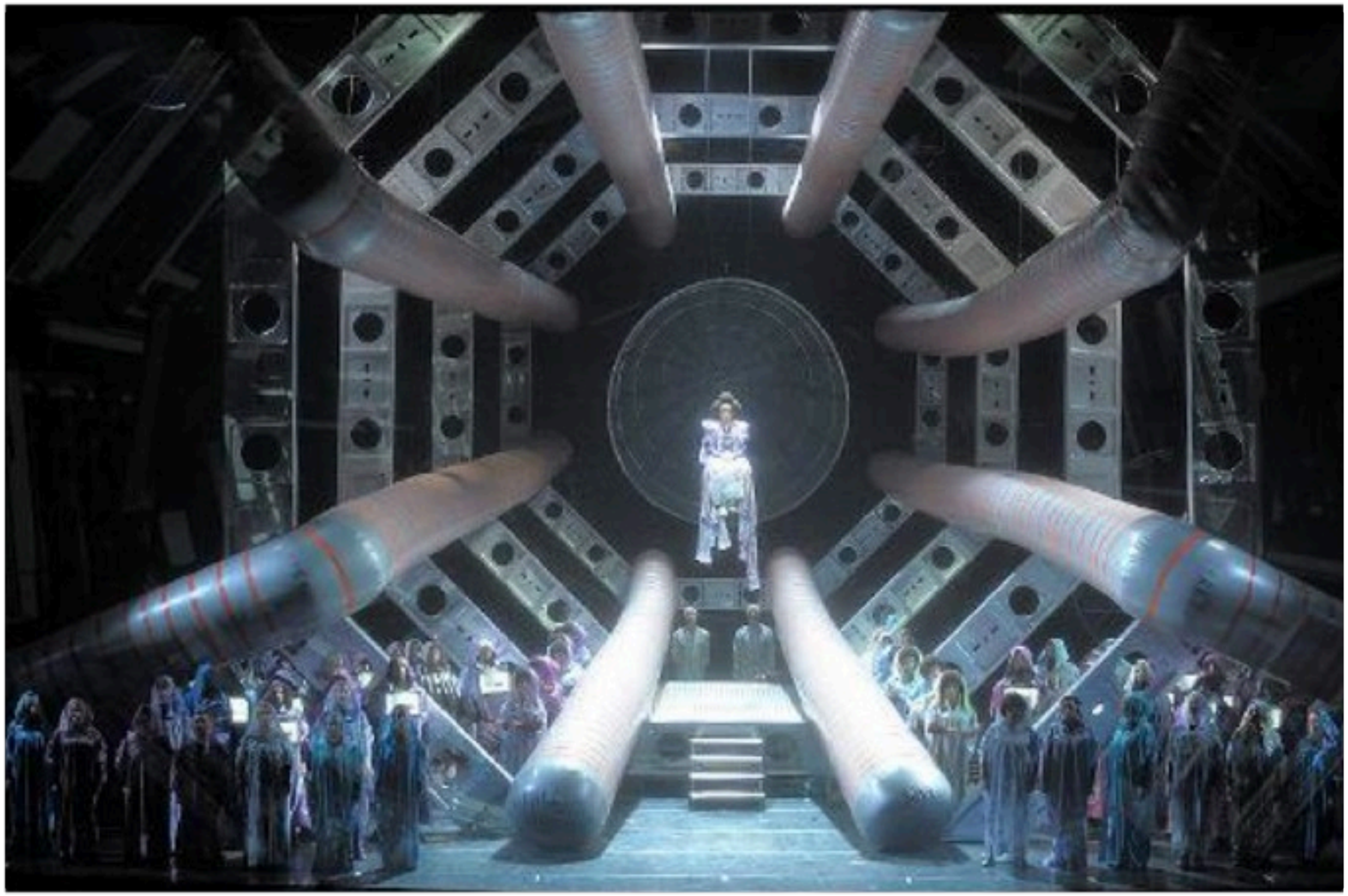
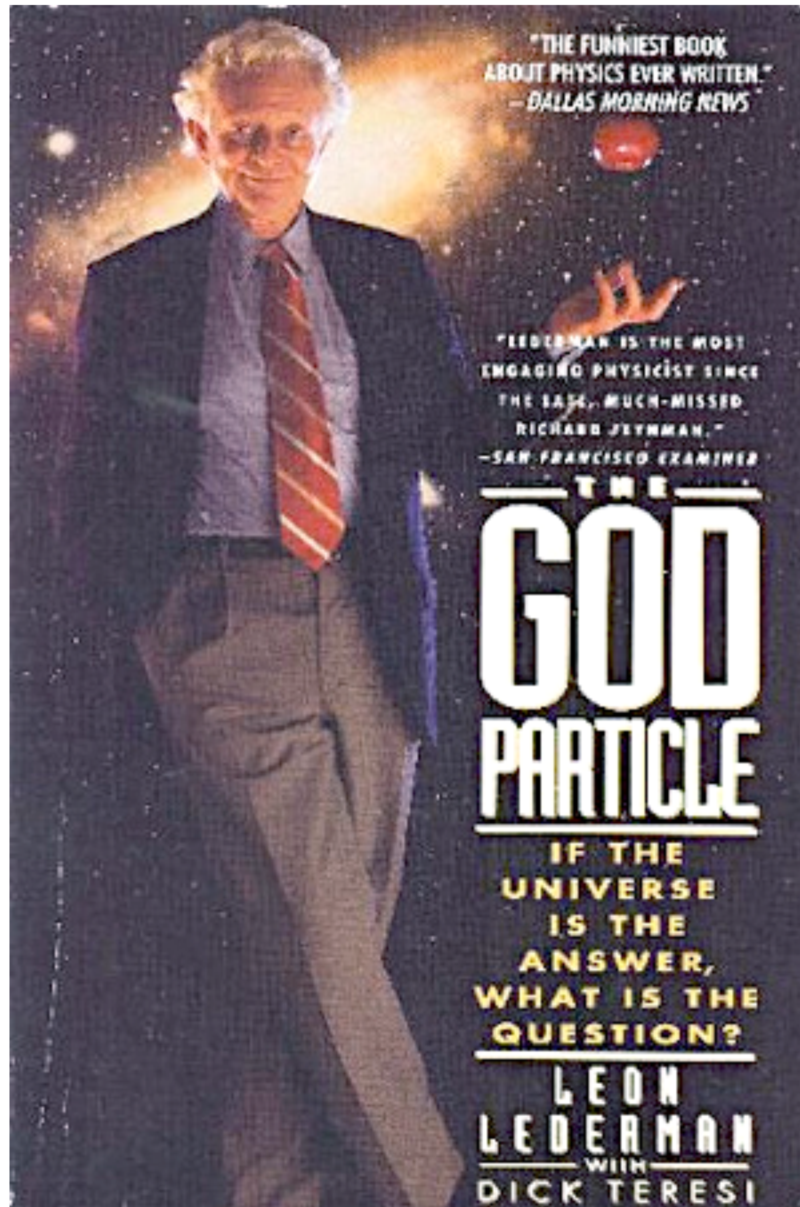


BR(t→Wb) =
= 99.82%
F.C.N.C...
t→Zc
t→Zu
t→γc
t→γu




"THE FUNNIEST BOOK ABOUT PHYSICS EVER WRITTEN."
—DALLAS MORNING NEWS
"LEDERMAN IS THE MOST ENGAGING PHYSICIST SINCE THE LATE, MUCH-MISSED RICHARD FEYNMAN."
—SAN FRANCISCO EXAMINER
THE
GOD PARTICLE
IF THE UNIVERSE IS THE ANSWER, WHAT IS THE QUESTION?
LEON LEDERMAN
WITH
DICK TERESI

nonetheless: 6,170,000 Google hits.

Because

the world has followed the Higgs Boson saga

we’re in a much different place than in previous times.

Following the post-July physics is going to be fun.

Conclusions

Yes. This Snowmass is a big deal

U.S. participation is essential!

European and Asian participation is essential!

For HEF, the Higgs payoff will still be fresh

Snowmass2013 <u>will</u> guide HEPAP Strategic Planning

Your colleagues need to be involved!

Find us on Facebook http://www.facebook.com/HEFrontier

http://www.snowmass2013.org/